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GAMMA SPECTRUM CATALOG - RHINO I WITH DECAY SCHEMES AND DETECTION EFFICIENCIES

Environmental Control Administration
Rockville, Maryland

1970

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WITH DECAY SCHEMES AND DETECTION EFFICIENCIES

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Training Institute
Rockville, Md. 20852

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PUBLIC HEALTH SERVICE
CONSUMER PROTECTION AND ENVIRONMENTAL HEALTH SERVICE

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Gamma Spectrum Catalog - Rhino I

I. INTRODUCTION

This catalog has been prepared specifically for trainees attending environmental radiological health training courses. Included are graphical representations of gamma spectra, nuclear decay schemes, detection efficiencies, and digital representation of gamma spectra. The information is grouped by nuclide and arranged in increasing order of mass number.

Data in this catalog, particularly counting efficiencies, should not be applied directly to other counting systems. The information, however, is useful for comparison purposes to other similar systems.

II. DESCRIPTION OF COUNTING SYSTEM

The counting system, located on the first basement floor of the Robert A. Taft Sanitary Engineering Center, is operated by the Environmental Radiological Health Training Section.

A. Detector

The detector is a 3" × 3" NaI(Tl) integral line crystal, and photomultiplier. The crystal is positioned on a rolling shelf inside a 20" × 20" × 24" six inch steel shield. The shield is made up of 1/4" steel plates and has 1/8" lead and 1/16" stainless steel liners.

B. Analyzer

The analyzer is a 400 multi-channel transistorized model. The data are collected in the first 100 channels with a channel coefficient of 20 Kev per channel. The data are read-out via a digital printer.

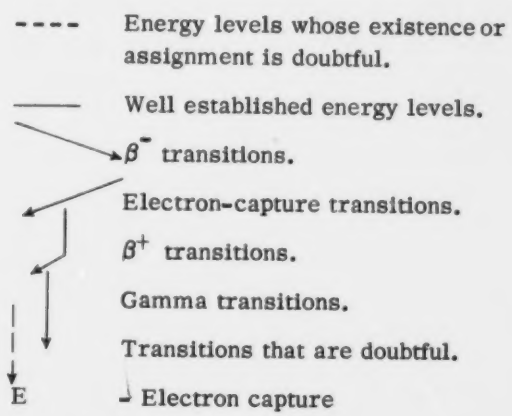
C. Counting Arrangement

All samples are counted in a "Marinelli" type beaker containing 3.5 liters of distilled water. This counting arrangement is designated as Class A.

III. DECAY SCHEME

The radionuclide is listed and is followed by its half-life in parenthesis. Only modes of decay related to gamma emissions are shown. The number located by each arrow represents the energy of transition followed by the percent abundance in parenthesis. It should be noted that all abundances refer to the original nuclide and no attempt has been made to adjust these percentages.

Decay Scheme Symbols



IV. EFFICIENCIES

The efficiencies calculated are defined as follows:

Total peak efficiency--
the summation of the net count rate in the peak channel divided by the disintegration rate of the sample.

Total photopeak efficiency--
the summation of the net count rate in a number of selected channels in the photopeak divided by the disintegration rate of the sample.

Total gross efficiency--
the summation of the net count rate under the spectrum divided by the disintegration rate of the sample.

The activity given is the total disintegration rate of the sample whether for a single nuclide or parent-daughter nuclides. The nuclide standards were obtained from the Standards Section of Radiological Health Research Activities.

V. DIGITAL DATA

In all cases, the digital data are listed as net counts per minute (gross minus background). The background, is a composite of five 1000 minute counts. It was necessary to break the background up into five separate counts due to limitations of the analyzer and to recalibrate the gain of the instrument. The samples are counted for 100 minutes and background subtracted. All sample data are listed as counts per minute, obtained by dividing total counts by the time of count. All significant figures are retained to facilitate future analyses.

VI. ACKNOWLEDGMENT

The Environmental Radiological Health Training Section wishes to acknowledge the Standards Section of Radiological Health Research for their contribution of the various radionuclide standards and for their suggestions and comments.

REFERENCES

1. Nuclear Data Sheets, National Academy of Sciences - National Research Council, 2101 Constitution Ave, Washington, D.C. 20418.

2. Heath, R. L. Scintillation Spectrometry Gamma Ray Spectrum Catalogue. AEC Research and Development Report 100-16408. 1957.

3. The Radiochemical Manual, Part 1: Physical Data. The Radiochemical Centre, Amersham, England. 1962.

4. Table of Isotopes, Radiological Health Handbook, U.S. Department of Health, Education, and Welfare. PHS, BSS. Division of Radiological Health, Washington, D.C. September, 1960.

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Composite Background I	Class A
Composite Background II	Class A
Composite Background III	Class A
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NUCLIDE	HALF-LIFE
Beryllium-7	53 days
Sodium-22	2.6 years
Potassium-40	1.7×10^9 years
Scandium-46	84 days
Chromium-51	28 days
Manganese-54	314 days
Iron-59	45 days
Cobalt-60	5.27 years
Zinc-65	245 days
Strontium-85	64 days
Yttrium-88	105 days
Niboium-95	35 days
Zirconium-Niobium-95	65 d - 35 d
Ruthenium-103	40 days
Ruthenium- Rhodium-106	1.0 year - 30 sec.
Antimony-125	2.7 years
Iodine-131	8.08 days
Cesium-132	6.5 days
Barium-133	7.2 years
Cesium-134	2.6 years
Cesium-137	30 years
Barium-Lanthanum-140	12.8 d - 40 hours
Cerium-141	33 days
Cerium-Praseodymiun-144	284 days - 17 min.
Europium-154	16 years
Mercury-203	47 days

RADIONUCLIDES ARRANGED BY GAMMA-RAY ENERGIES

The table presented here lists radionuclides in order of the energies of their emitted photons. The listing covers only those nuclides found in this catalogue whose energies are recorded on the spectra.

For use in identifying nuclides by gamma-scintillation spectrometry, the lists includes other data along with the photopeak energy. This list is also useful in finding photon energies for calibration purposes.

ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS*
0.079	Ba^{133}	7.2 y	0.079	16	
0.081			0.081	92	
			0.160	2	
			0.220	0.1	
			0.355	60	
			0.380	6	
0.1231	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	
0.134	Ce^{144}-Pr^{144}	284d-17m	0.134	5.6	
			0.691	1.6	
			1.49	0.26	
0.145	Ce^{141}	33d	0.145	49	
0.156	I^{131}	8.08d	0.156	1	
			0.284	5.5	
			0.364	81	
			0.51		
			0.638	9	
			0.724	2.8	
0.160	Ba^{133}	7.2 y	0.079	16	
			0.081	92	
			0.160	2	
			0.220	0.1	
			0.355	60	
			0.380	6	

ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS*
0.162	Ba^{140}-La^{140}	12.8d-40hr.	0.162	5.9	
			0.329	30	
			0.436	5	
			0.487	50	
			0.537	25	
			0.815	46	
			0.923	10	
			1.60	100	
			1.902	0.15	
0.176	Sb^{125}	2.7 y	0.176	6.8	
			0.427	31	
			0.598	19	
			0.604	5.2	
			0.633	11	
0.191	Fe^{59}	45d	0.191	2.8	
			1.097	57	
			1.287	44	
0.220	Ba^{133}	7.2 y	0.079	16	
			0.080	92	
			0.160	2	
			0.220	0.1	
			0.355	60	
			0.380	6	
0.235	Zr^{95}-Nb^{95}	65d-35d	0.235	2	
			0.726	55	
			0.760	43	
			0.768	99	
0.248	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	
0.279	Hg^{203}	47d	0.279	100	
0.284	I^{131}	8.08d	0.156	1	
			0.284	5.5	
			0.364	81	
			0.51		
			0.638	9	
			0.724	2.8	
0.320	Cr^{51}	28d	0.320	9	

ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS
0.329	Ba^{140}-La^{140}	12.8d-40hr.	0.162	5.9	
			0.329	30	
			0.436	5	
			0.487	50	
			0.537	25	
			0.815	46	
			0.923	10	
			1.60	100	
			1.902	0.15	
0.355	Ba^{133}	7.2 y	0.079	16	
			0.081	92	
			0.160	2	
			0.220	0.1	
			0.355	60	
			0.380	6	
0.364	I^{131}	8.08d	0.156	1	
			0.284	5.5	
			0.364	81	
			0.51		
			0.638	9	
			0.724	2.8	
0.380	Ba^{133}	7.2 y	0.079	16	
			0.081	92	
			0.160	2	
			0.220	0.1	
			0.355	60	
			0.380	6	
0.427	Sb^{125}	2.7 y	0.176	6.8	
			0.427	31	
			0.598	19	
			0.604	5.2	
			0.633	11	
0.478	Be^{7}	53d	0.478	12	
0.436	Ba^{140}-La^{140}	12.8d-40hr.	0.162	5.9	
0.487			0.329	30	
			0.436	5	
			0.487	50	
			0.537	25	
			0.815	46	
			0.923	10	
			1.60	100	
			1.902	0.15	
0.493	Ru^{103}	40d	0.498	88.5	
			0.610	6.5	

ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS*
0.51	I^{131}	8.08d	0.156	1	
			0.284	5.5	
			0.364	81	
			0.51		
			0.638	9	
			0.724	2.8	
0.511	Na^{22}	2.6 y	0.511		AR
			1.274		
			1.785		SP
	Zn^{65}	245d	0.511		AR
			1.114	49	
0.513	Ru^{106}-Rh^{106}	1.0y-30 sec	0.513	20.5	
			0.624	9.9	
			0.88	0.7	
			1.045	1.5	
			1.14	0.7	
			1.56	0.23	
			1.77	0.04	
0.514	Sr^{85}	64d	0.514	100	
0.537	Ba^{140}-La^{140}	12.8d-40 hr.	0.162	5.9	
			0.329	30	
			0.436	5	
			0.487	50	
			0.537	25	
			0.815	46	
			0.923	10	
			1.60	100	
			1.902	0.15	
0.563	Cs^{134}	2.6 y	0.563	14	
			0.605	98	
			0.797	72.5	
			1.038	5	
			1.168	2.5	
			1.402		SP
0.591	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	

ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS*
0.598	Sb^{125}	2.7 y	0.176	6.8	
			0.427	31	
			0.598	19	
			0.604	5.2	
			0.633	11	
0.605	Cs^{134}	2.6 y	0.563	14	
			0.605	98	
			0.797	72.5	
			1.038	5	
			1.168	2.5	
			1.402		SP
0.610	Ru^{103}	40d	0.498	88.5	
			0.610	6.5	
0.624	Ru^{106}-Rh^{106}	1.0y-30 sec	0.513	20.5	
			0.624	9.9	
			0.88	0.7	
			1.045	1.5	
			1.14	0.7	
			1.56	0.23	
			1.77	0.04	
0.633	Sb^{125}	2.7 y	0.176	6.8	
			0.427	31	
			0.598	19	
			0.604	5.2	
			0.633	11	
0.638	I^{131}	8.08d	0.156	1	
			0.284	5.5	
			0.364	81	
			0.51		
			0.638	9	
			0.724	2.8	
0.6616	Cs^{137}	30y	0.6616	82	
0.673	Cs^{132}	6.5d	0.673	99	
			1.04	0.23	
			1.14	0.55	
			1.32		SP
0.725	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	
0.726	Zr^{95}-Nb^{95}	65d-35d	0.235	2	
			0.726	55	
			0.760	43	
			0.768	99	

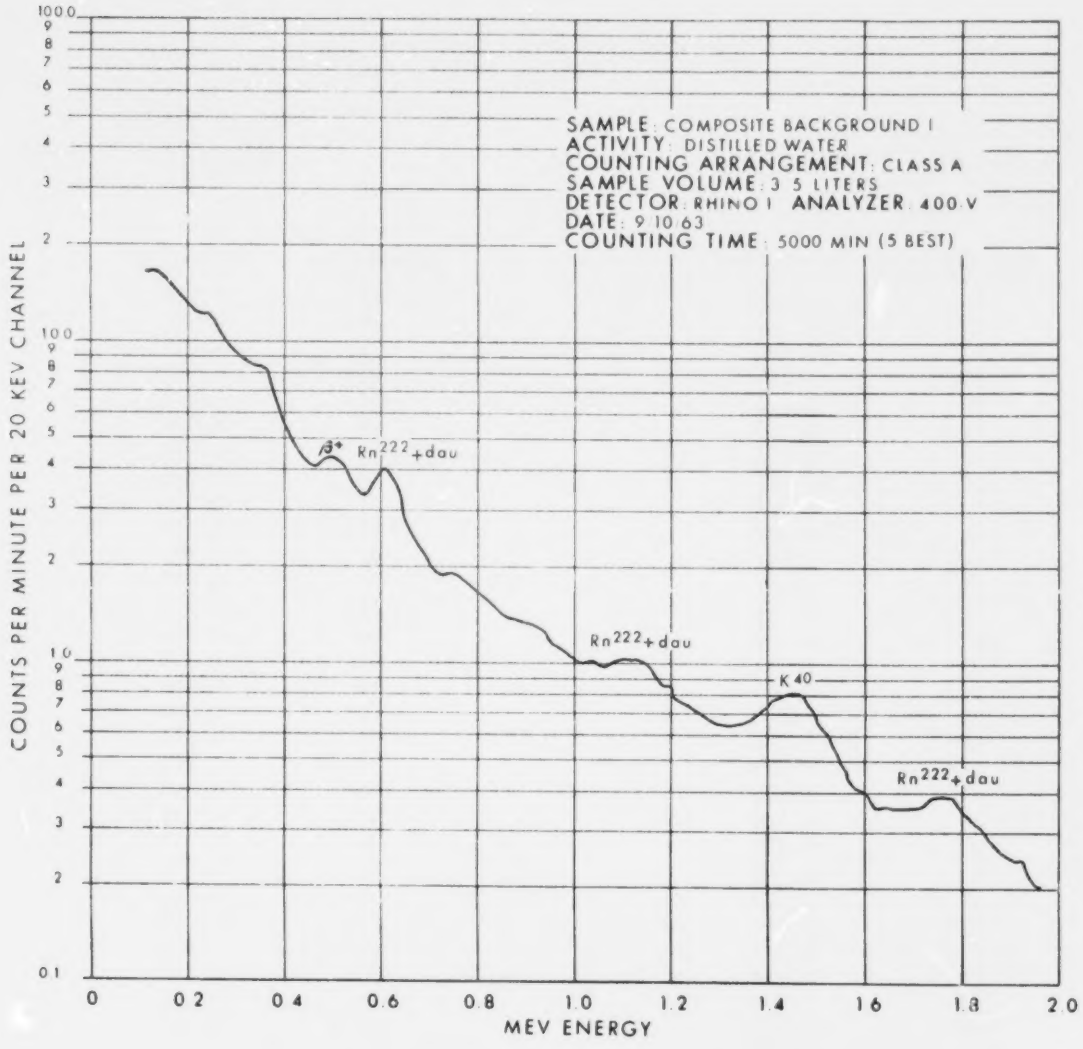
ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS*
0.758	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	
0.760	Zr^{95}-Nb^{95}	65d-35d	0.235	2	
			0.726	55	
			0.760	43	
			0.768	99	
0.768	Nb^{95}	35d	0.768	99	
0.797	Cs^{134}	2.6 y	0.563	14	
			0.605	98	
			0.797	72.5	
			1.038	5	
			1.168	2.5	
			1.402		SP
0.815	Ba^{140}-La^{140}	12.8d-40 hr.	0.162	5.9	
			0.329	30	
			0.436	5	
			0.487	50	
			0.537	25	
			0.815	46	
			0.923	10	
			1.60	100	
			1.902	0.15	
0.835	Mn^{54}	314d	0.835	100	
0.875	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	
0.88	Ru^{106}-Rh^{106}	1.0y-30 sec	0.513	20.5	
			0.624	0.9	
			0.88	0.7	
			1.045	1.5	
			1.14	0.7	
			1.56	0.23	
			1.77	0.04	

ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS*
0.887	Sc^{46}	84d	0.887	100	
			1.119	100	
0.899	Y^{88}	105d	0.899	92	
			1.85	100	
0.923	Ba^{140}-La^{140}	12.8d-40hr.	0.162	5.9	
			0.329	80	
			0.436	5	
			0.487	50	
			0.537	25	
			0.815	46	
			0.923	10	
			1.60	100	
			1.902	0.15	
0.998	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	
1.038	Cs^{134}	2.6 y	0.563	14	
			0.605	98	
			0.797	72.5	
			1.038	5	
			1.168	2.5	
			1.402		SP
1.045	Ru^{106}-Rh^{106}	1.0y-30 sec	0.513	20.5	
			0.624	9.9	
			0.88	0.7	
			1.045	1.5	
			1.14	0.7	
			1.56	0.23	
			1.77	0.04	
1.097	Fe^{59}	45d	0.191	2.8	
			1.097	57	
			1.287	44	
1.114	Zn^{65}	245d	0.511		AR
			1.114	49	
1.119	Sc^{46}	84d	0.887	100	
			1.119	100	

ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS*
1.14	Ru^{106}-Rh^{106}	1.0y-30 sec	0.513	20.5	
			0.624	9.9	
			0.88	0.7	
			1.045	1.5	
			1.14	0.7	
			1.56	0.23	
			1.77	0.04	
1.165	Cs^{134}	2.6 y	0.563	14	
			0.605	98	
			0.797	72.5	
			1.038	5	
			1.168	2.5	
			1.402		SP
1.17	Co^{60}	5.27 y	1.17	100	
			1.33	100	
1.274	Na^{22}	2.6 y	0.511		
			1.274		
			1.785		SP
1.28	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	
1.287	Fe^{59}	45d	0.191	2.8	
			1.097	57	
			1.287	44	
1.33	Co^{60}	5.27 y	1.17	100	
			1.33	100	
1.402	Cs^{134}	2.6 y	0.563	14	
			0.605	98	
			0.797	72.5	
			1.038	5	
			1.168	2.5	
			1.402		SP
1.46	K^{40}	1.27×10^{9}y	1.46	10.95	
1.49	Ce^{144}-Pr^{144}	284d-17m	0.134	5.6	
			0.691	1.6	
			1.49	0.26	

ENERGY (MEV)	NUCLIDE	HALF-LIFE	SPECTRUM	ABUNDANCE (%)	REMARKS*
1.56	Ru^{106}-Rh^{106}	1.0y-30 sec	0.513	20.5	
			0.624	9.9	
			0.88	0.7	
			1.045	1.5	
			1.14	0.7	
			1.56	0.23	
			1.77	0.04	
1.60	Ba^{140}-La^{140}	12.8d-40hr.	0.162	5.9	
			0.329	30	
			0.436	5	
			0.487	50	
			0.537	25	
			0.815	46	
			0.923	10	
			1.60	100	
			1.902	0.15	
1.60	Eu^{154}	16 y	0.1231	81	
			0.248	18	
			0.591	15	
			0.725	64	
			0.758	29	
			0.875	39	
			0.998	33	
			1.006	42	
			1.28	100	
			1.60	4	
1.77	Ru^{106}-Rh^{106}	1.0y-30 sec	0.513	20.5	
			0.624	9.9	
			0.88	0.7	
			1.045	1.5	
			1.14	0.7	
			1.56	0.23	
			1.77	0.04	
1.785	Na^{22}	2.6 y	0.511		AR
			1.274		
			1.785		
1.85	Y^{88}	105d	0.899	92	
			1.85	100	
1.902	Ba^{140}-La^{140}	12.8d-40hr.	0.162	5.9	
			0.329	30	
			0.436	5	
			0.487	50	
			0.537	25	
			0.815	46	
			0.923	10	
			1.60	100	
			1.902	0.15	

*AR - Annihilation Radiation
SP - Sum Peak

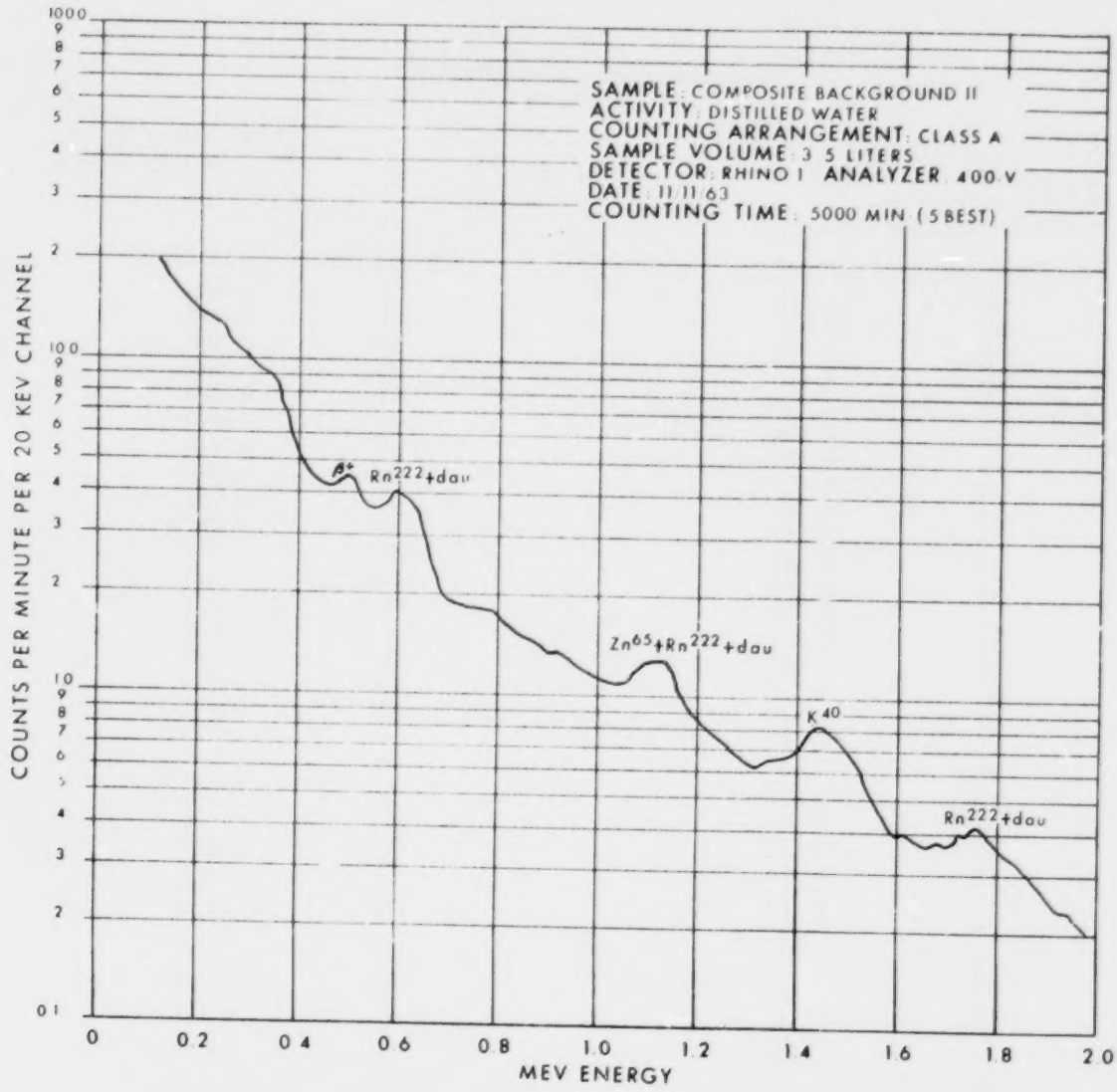

SAMPLE: COMPOSITE BACKGROUND I
ACTIVITY: DISTILLED WATER
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400 V
DATE: 9 10 63
COUNTING TIME: 5000 MIN (5 BEST)
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
β+ Rn222+dau
Rn222+dau
K40
Rn222+dau

BACKGROUND FOR RHINO-I (I)
9-10-63

TIME: 5000 min. (5 best)
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: Distilled Water

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
06	16.989	53	0.978
07	16.572	54	1.000
08	15.622	55	1.027
09	14.293	56	1.027
10	13.478	57	1.005
11	12.722	58	0.970
12	12.591	59	0.874
13	11.118	60	0.843
14	9.915	61	0.771
15	9.289	62	0.756
16	8.847	63	0.708
17	8.583	64	0.677
18	8.156	65	0.648
19	6.450	66	0.649
20	5.301	67	0.647
21	4.577	68	0.674
22	4.290	69	0.686
23	4.136	70	0.754
24	4.338	71	0.797
25	4.483	72	0.810
26	4.189	73	0.809
27	3.586	74	0.779
28	3.378	75	0.674
29	3.673	76	0.612
30	4.023	77	0.516
31	3.753	78	0.478
32	3.183	79	0.420
33	2.609	80	0.410
34	2.213	81	0.367
35	1.934	82	0.367
36	1.869	83	0.359
37	1.877	84	0.358
38	1.859	85	0.368
39	1.716	86	0.373
40	1.683	87	0.398
41	1.532	88	0.397
42	1.475	89	0.392
43	1.399	90	0.352
44	1.367	91	0.332
45	1.310	92	0.306
46	1.297	93	0.286
47	1.207	94	0.251
48	1.169	95	0.245
49	1.112	96	0.243
50	1.055	97	0.216
51	1.009	98	0.205
52	1.009	99	0.208
		Total	275.258

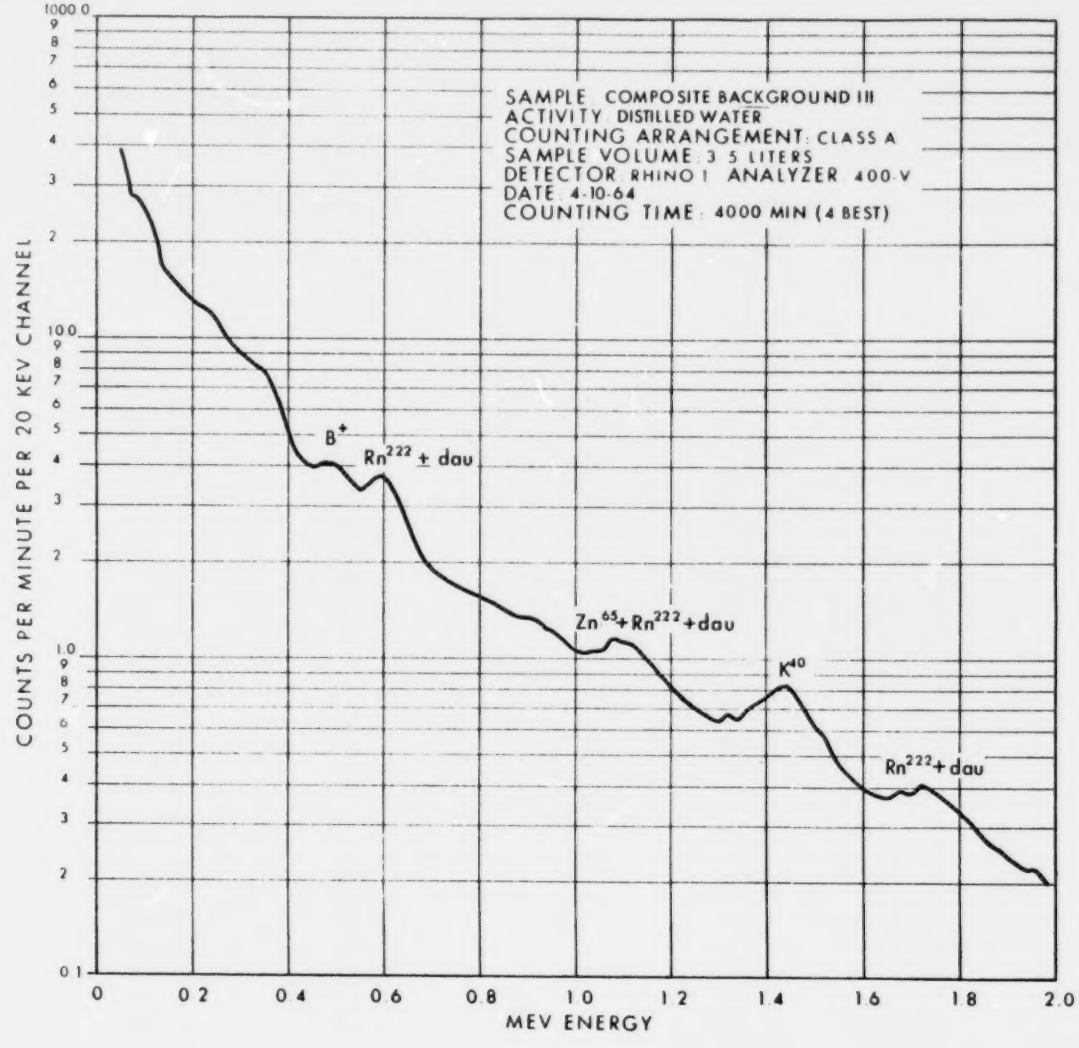

SAMPLE: COMPOSITE BACKGROUND II
ACTIVITY: DISTILLED WATER
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER 400 V
DATE: 11 11 63
COUNTING TIME: 5000 MIN (5 BEST)
A+ Rn222+dau
Zn65+Rn222+dau
K40
Rn222+dau
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
1000
100
10
1
0
0 2
0 4
0 6
0 8
1.0
1.2
1.4
1.6
1.8
2 0

BACKGROUND FOR RHINO-I (II)
11-11-63

TIME: 5000 min. (5 best)
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: Distilled Water

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
06	19.679	53	1.135
07	17.291	54	1.280
08	16.196	55	1.284
09	14.910	56	1.280
10	14.044	57	1.286
11	13.280	58	1.099
12	13.100	59	0.940
13	11.593	60	0.875
14	10.616	61	0.796
15	10.041	62	0.778
16	9.589	63	0.713
17	9.234	64	0.694
18	8.322	65	0.658
19	6.641	66	0.636
20	5.389	67	0.653
21	4.677	68	0.670
22	4.388	69	0.668
23	4.213	70	0.709
24	4.326	71	0.791
25	4.525	72	0.826
26	4.249	73	0.811
27	3.683	74	0.753
28	3.574	75	0.692
29	3.812	76	0.623
30	4.121	77	0.536
31	3.840	78	0.480
32	3.207	79	0.410
33	2.571	80	0.399
34	2.190	81	0.388
35	1.944	82	0.376
36	1.899	83	0.364
37	1.851	84	0.377
38	1.825	85	0.366
39	1.811	86	0.394
40	1.715	87	0.395
41	1.614	88	0.411
42	1.545	89	0.381
43	1.500	90	0.359
44	1.416	91	0.345
45	1.378	92	0.321
46	1.370	93	0.300
47	1.284	94	0.271
48	1.255	95	0.255
49	1.188	96	0.235
50	1.143	97	0.231
51	1.107	98	0.217
52	1.112	99	0.202
		Total	288.820

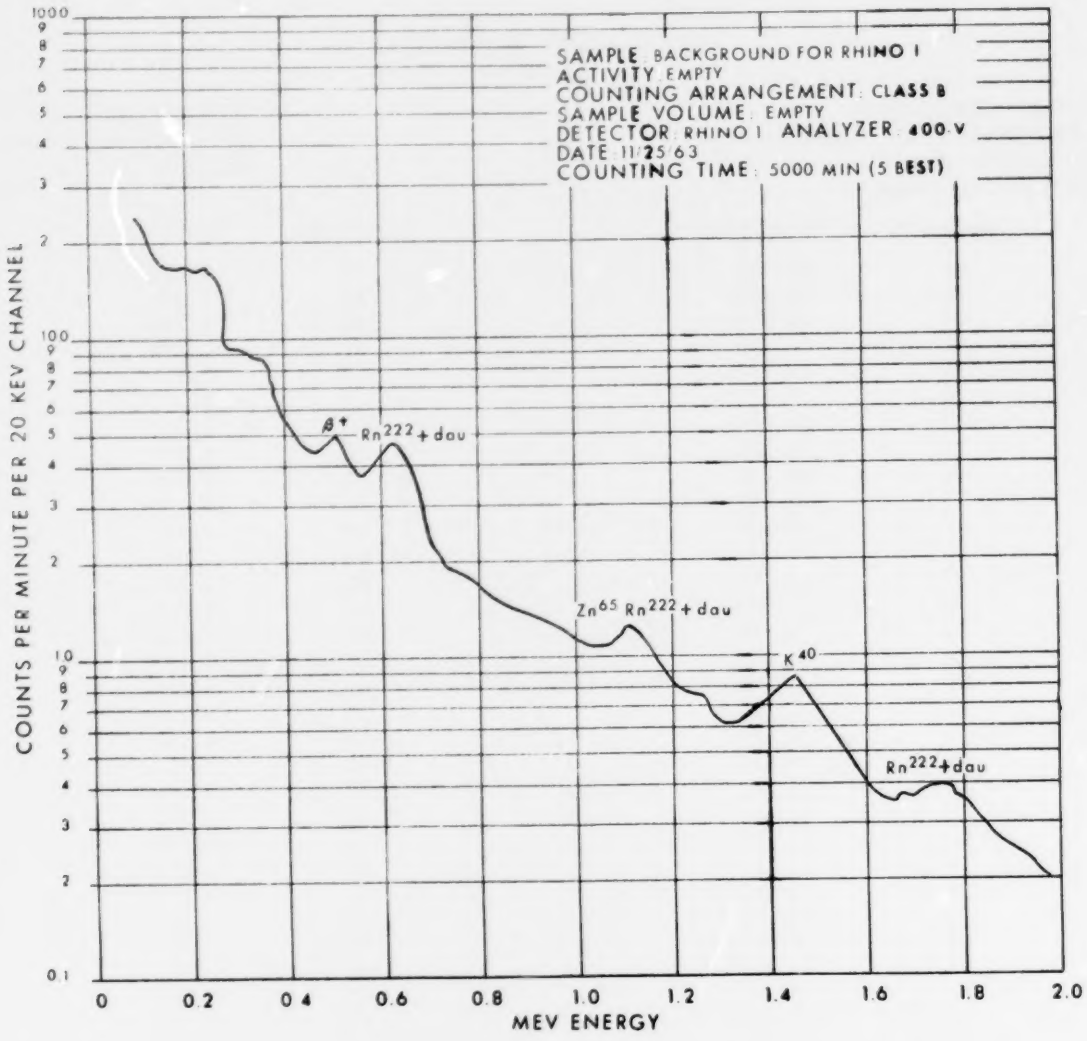

SAMPLE COMPOSITE BACKGROUND III
ACTIVITY DISTILLED WATER
COUNTING ARRANGEMENT CLASS A
SAMPLE VOLUME 3 5 LITERS
DETECTOR RHINO I ANALYZER 400 V
DATE 4-10-64
COUNTING TIME 4000 MIN (4 BEST)
B+
Rn222 ± dau
Zn65+Rn222+dau
K40
Rn222+dau
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
1000 0
100
1.0
0.1
0
0 2
0 4
0.6
0.8
1 0
1 2
1.4
1.6
1.8
2.0

BACKGROUND FOR RHINO I (III)
4-10-64

TIME: 4000 (4 best)
ARRANGEMENT: Class A
VOLUME: 3.5 liter
ACTIVITY: Distilled Water

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
03	30.816
04	27.248
05	26.898
06	22.973
07	17.659
08	15.940
09	14.649
10	13.412
11	12.571
12	12.342
13	11.415
14	9.981
15	9.145
16	8.494
17	8.283
18	7.986
19	6.607
20	5.411
21	4.490
22	4.154
23	3.978
24	4.026
25	4.040
26	3.865
27	3.518
28	3.393
29	3.616
30	3.758
31	3.531
32	2.986
33	2.472
34	2.103
35	1.886
36	1.804
37	1.738
38	1.683
39	1.619
40	1.594
41	1.529
42	1.461
43	1.415
44	1.359
45	1.347
46	1.326
47	1.239
48	1.218
49	1.142
50	1.067
51	1.046
52	1.052
53	1.084
54	1.175
55	1.168
56	1.124
57	1.047
58	0.959
59	0.894
60	0.842
61	0.763
62	0.712
63	0.694
64	0.668
65	0.637
66	0.681
67	0.652
68	0.710
69	0.735
70	0.764
71	0.815
72	0.831
73	0.773
74	0.698
75	0.619
76	0.566
77	0.482
78	0.446
79	0.413
80	0.395
81	0.384
82	0.376
83	0.368
84	0.387
85	0.367
86	0.413
87	0.393
88	0.374
89	0.359
90	0.333
91	0.320
92	0.289
93	0.264
94	0.254
95	0.248
96	0.232
97	0.222
98	0.224
99	0.204
Total	364.643


SAMPLE: BACKGROUND FOR RHINO I
ACTIVITY: EMPTY
COUNTING ARRANGEMENT: CLASS B
SAMPLE VOLUME: EMPTY
DETECTOR: RHINO I ANALYZER: 400 V
DATE: 11/25/63
COUNTING TIME: 5000 MIN (5 BEST)
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
β+ Rn222 + dau
Zn65 Rn222 + dau
K40
Rn222 + dau

BACKGROUND FOR RHINO I
11-25-63

TIME: 5000 (5 best)
ARRANGEMENT: Class B
VOLUME: Empty
ACTIVITY: Empty

20 Kev/channel
Net counts per minute
RHINO I

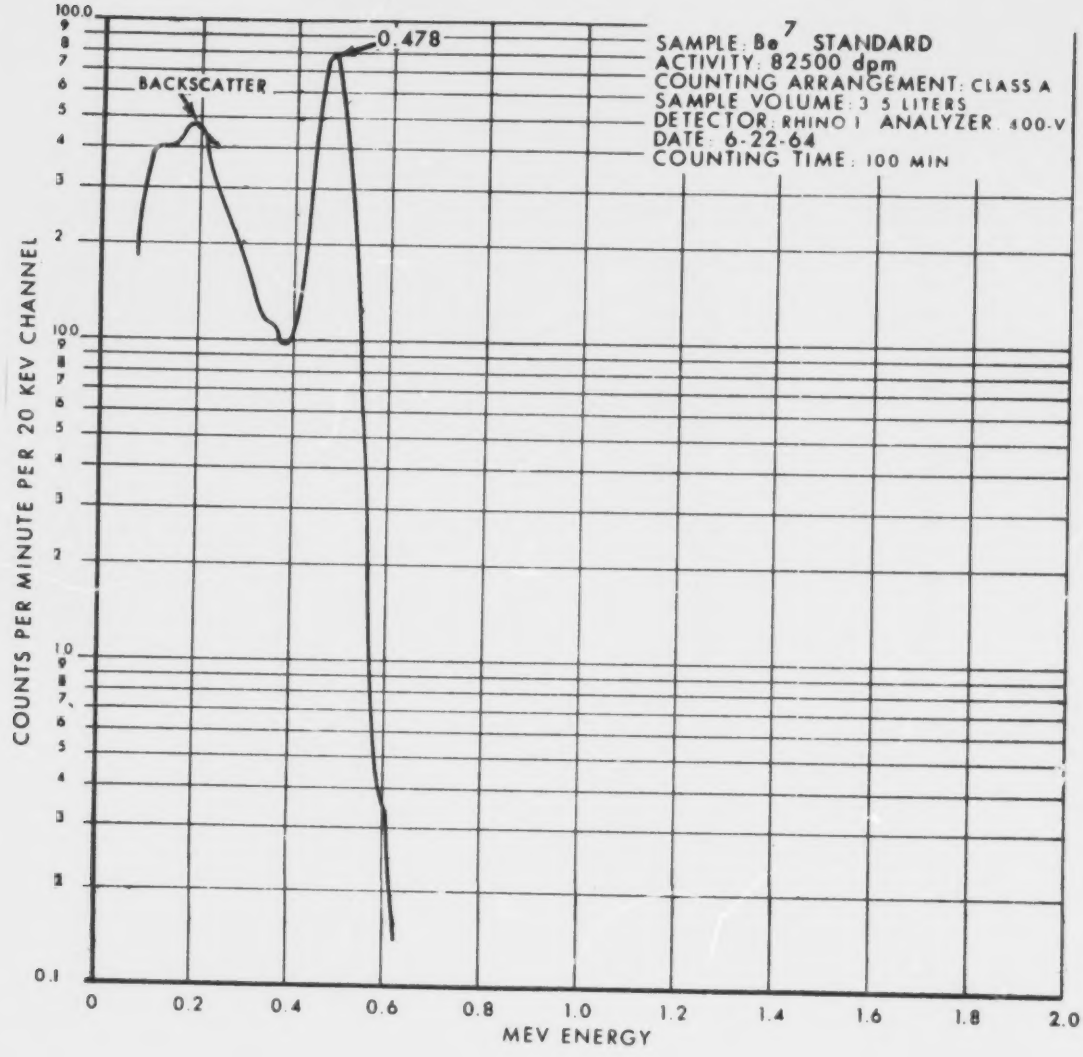
Channel No.	Count Rate	Channel No.	Count Rate
05	23.399	53	1.130
06	15.140	54	1.130
07	12.333	55	1.249
08	11.955	56	1.236
09	11.727	57	1.157
10	11.537	58	1.053
11	11.207	59	0.911
12	11.530	60	0.847
13	10.678	61	0.794
14	9.536	62	0.763
15	9.395	63	0.716
16	9.081	64	0.648
17	8.880	65	0.621
18	8.292	66	0.626
19	6.813	67	0.628
20	5.604	68	0.667
21	4.920	69	0.692
22	4.624	70	0.728
23	4.416	71	0.792
24	4.658	72	0.821
25	4.945	73	0.840
26	4.687	74	0.763
27	3.973	75	0.684
28	3.721	76	0.598
29	3.941	77	0.513
30	4.402	78	0.484
31	4.609	79	0.449
32	4.418	80	0.386
33	3.896	81	0.366
34	3.108	82	0.360
35	2.356	83	0.352
36	2.023	84	0.372
37	1.872	85	0.365
38	1.854	86	0.381
39	1.729	87	0.386
40	1.699	88	0.391
41	1.588	89	0.379
42	1.520	90	0.355
43	1.447	91	0.335
44	1.416	92	0.305
45	1.368	93	0.277
46	1.339	94	0.262
47	1.289	95	0.250
48	1.229	96	0.241
49	1.176	97	0.225
50	1.126	98	0.210
51	1.098	99	0.203
52	1.093		
		Total	292.637

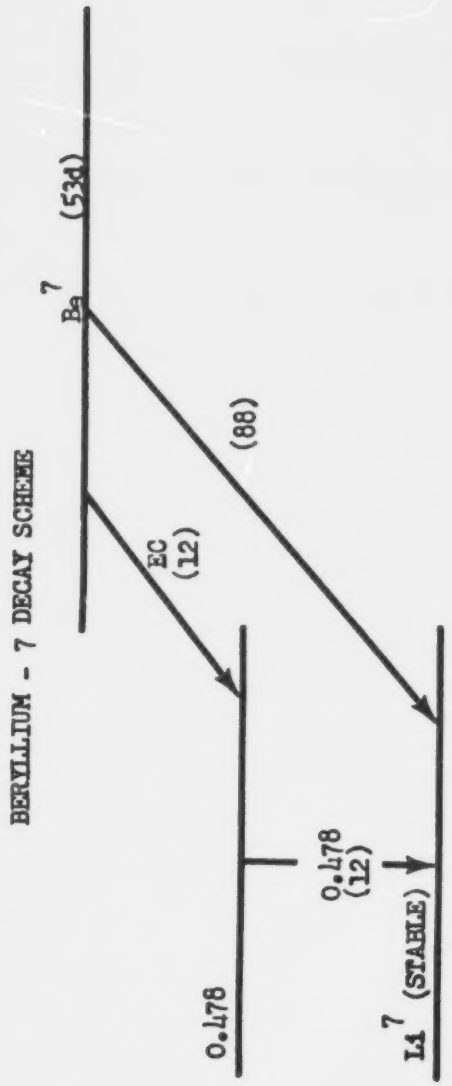
Be^7 STANDARD
6/22/64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 Liters
ACTIVITY: 82500 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Net Counts	Channel No.	Net Counts
04	18.97	20	10.26
05	34.83	21	13.86
06	40.07	22	32.34
07	40.49	23	61.07
08	42.14	24	77.09
09	47.96	25	55.19
10	47.86	26	25.35
11	37.70	27	8.09
12	31.25	28	2.02
13	25.83	29	0.41
14	21.83	30	0.35
15	18.13	31	0.14
16	14.75	32	0.14
17	11.88	33	0.00
18	11.17	34	0.00
19	9.64	35	0.00


SAMPLE: Be 7 STANDARD
ACTIVITY: 82500 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER 400-V
DATE: 6-22-64
COUNTING TIME: 100 MIN
BACKSCATTER
0.478
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
100.0
100
10
1.0
0.1
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0


BERYLLIUM - 7 DECAY SCHEME
Be^7
(53d)
EC
(12)
(88)
0.478
0.478
(12)
Li^7 (STABLE)

Be^7 EFFICIENCIES
6/22/64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 Liters
ACTIVITY: 82500 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in channel 24}}{\text{dpm}} = \frac{77.09}{82500} = 0.000934$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in channels 21-27}}{\text{dpm}} = \frac{272.99}{82500} = 0.00331$

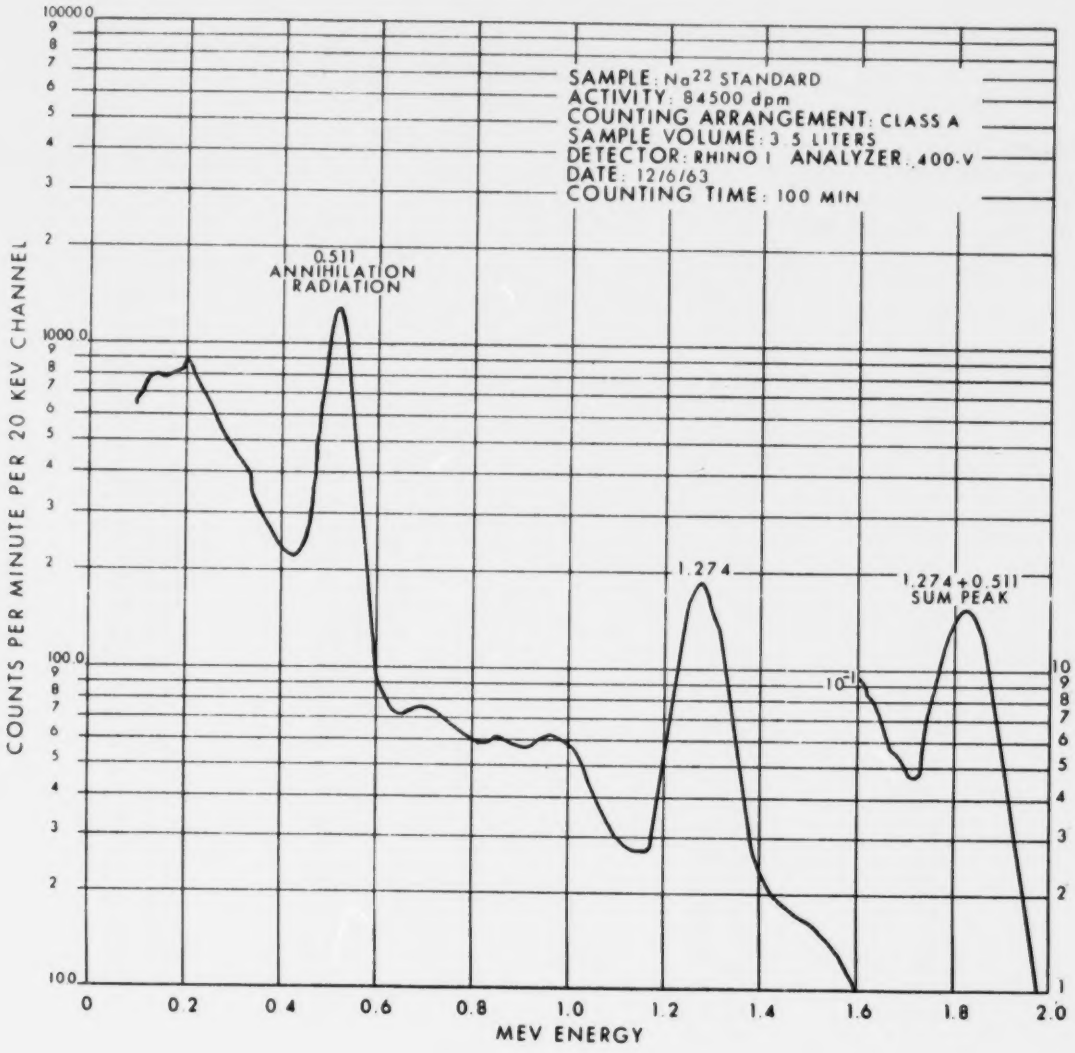
Total Gross Eff. $= \frac{\Sigma \text{ counts in channels 4-99}}{\text{dpm}} = \frac{740.45}{82500} = 0.00898$

Na^{22} STANDARD
12-6-63

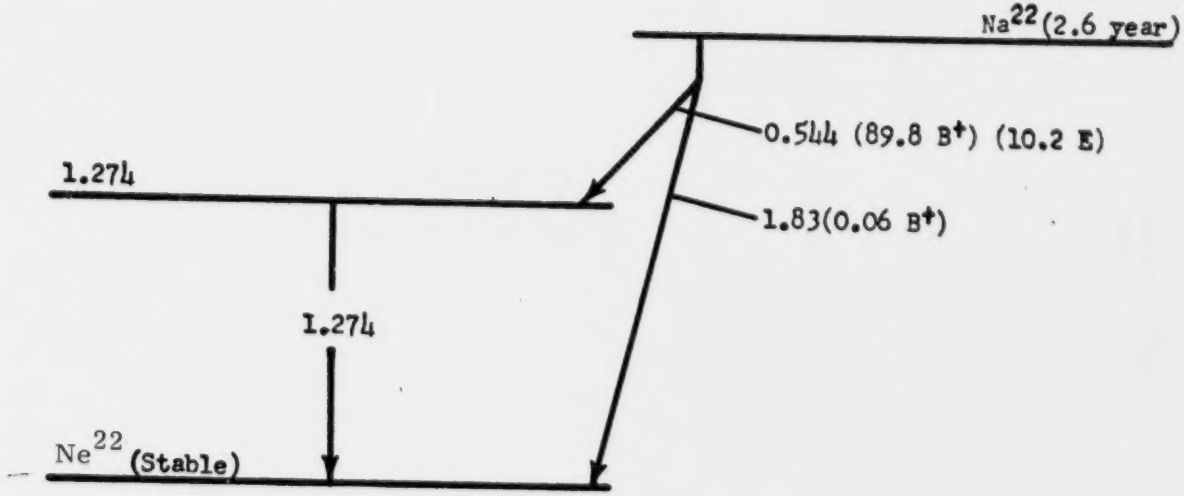
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 84,500 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
05	652.25	53	39.83
06	761.80	54	34.23
07	793.39	55	30.77
08	781.00	56	28.23
09	801.43	57	27.43
10	850.16	58	27.37
11	771.82	59	35.01
12	675.23	60	54.24
13	580.49	61	92.17
14	520.90	62	141.72
15	462.10	63	175.84
16	408.54	64	181.40
17	341.12	65	157.01
18	291.01	66	116.18
19	253.77	67	74.49
20	237.68	68	46.71
21	222.08	69	31.84
22	229.31	70	24.49
23	314.01	71	19.99
24	643.53	72	18.74
25	1122.35	73	17.74
26	1250.99	74	17.01
27	827.57	75	15.48
28	382.98	76	15.23
29	160.07	77	14.10
30	94.39	78	13.02
31	78.30	79	11.59
32	73.53	80	9.81
33	74.43	81	8.41
34	76.14	82	7.68
35	74.88	83	5.83
36	72.51	84	5.49
37	69.91	85	4.79
38	66.68	86	4.77
39	62.38	87	7.25
40	61.92	88	9.39
41	59.65	89	12.07
42	61.30	90	14.54
43	60.48	91	15.50
44	59.17	92	14.41
45	58.68	93	12.15
46	58.14	94	8.07
47	61.00	95	5.42
48	61.11	96	3.56
49	59.98	97	2.01
50	58.60	98	1.35
51	52.83	99	0.90
52	46.50		


SAMPLE: Na22 STANDARD
ACTIVITY: 84500 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER 400-V
DATE: 12/6/63
COUNTING TIME: 100 MIN
0.511 ANNIHILATION RADIATION
1.274
1.274+0.511 SUM PEAK
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0

Sodium 22 DECAY SCHEME December 23, 1963



Na^{22} EFFICIENCIES
12-6-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 84,500 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in channel 64}}{\text{dpm}} = \frac{181.40}{84500} = 0.00215$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in channels 60-68}}{\text{dpm}} = \frac{1039.76}{84500} = 0.0123$$

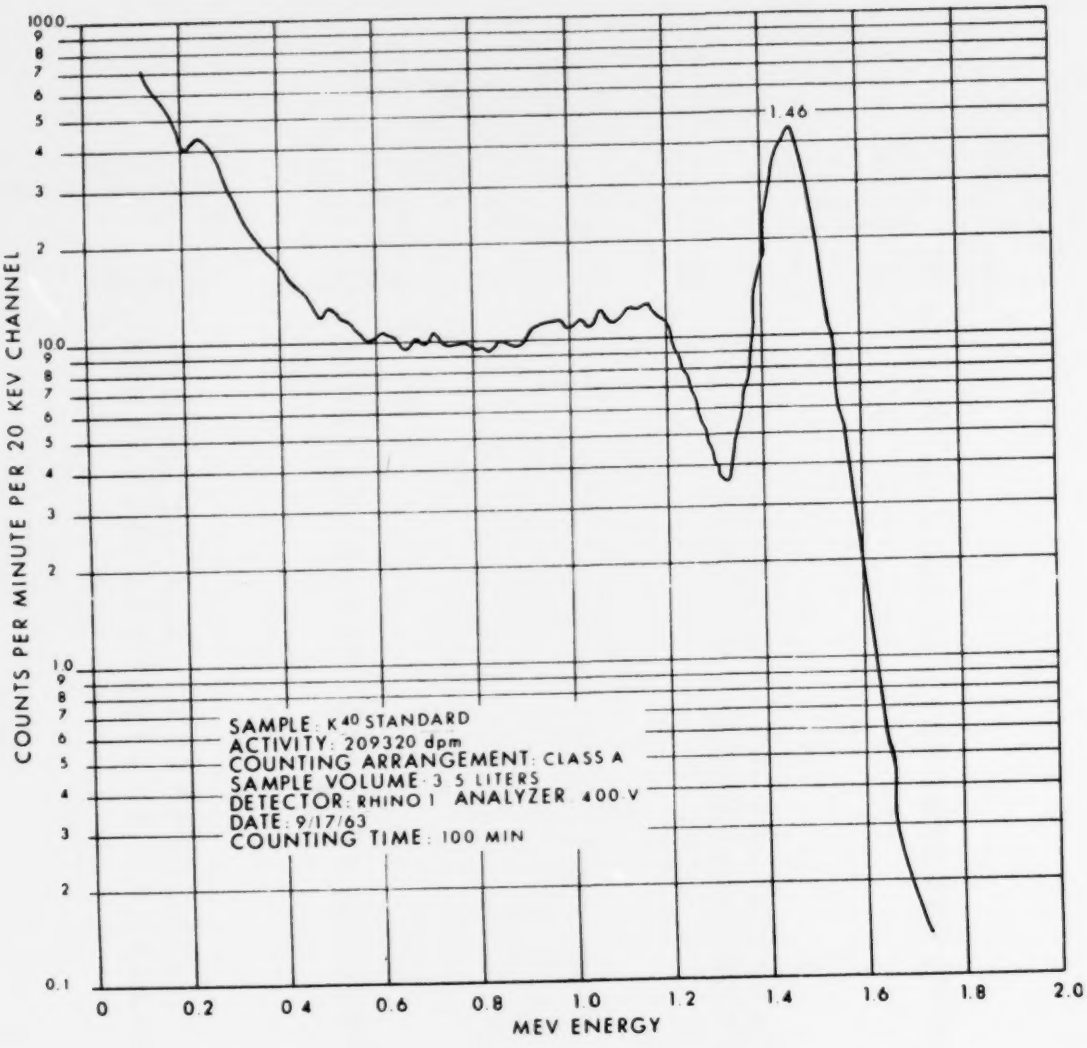
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in channels 5-99}}{\text{dpm}} = \frac{17453.35}{84500} = 0.206$$

K^{40} STANDARD
9-17-63

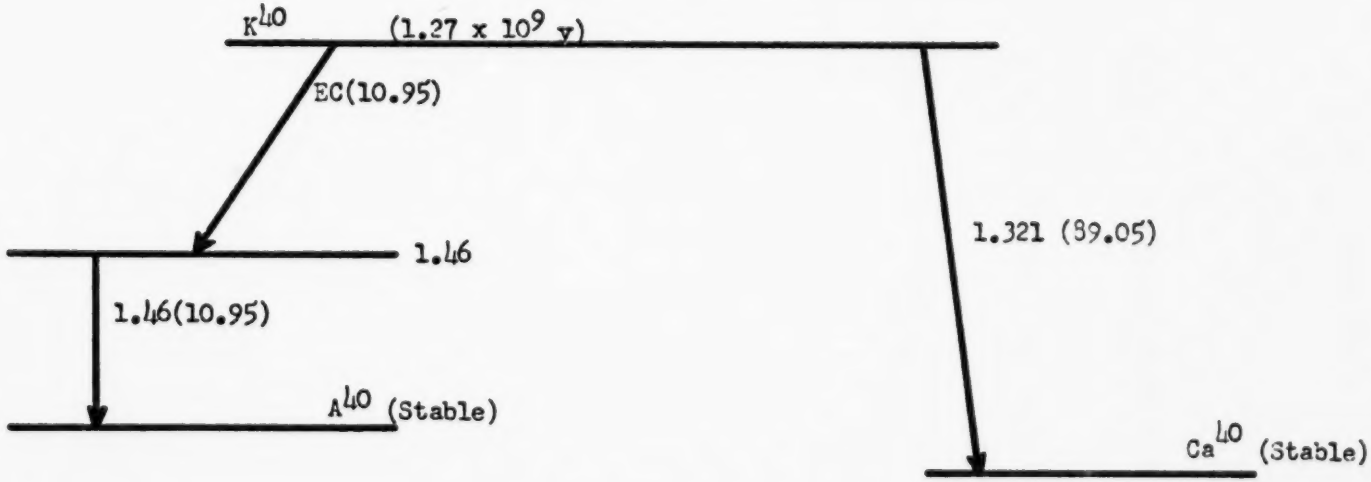
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 209320 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
06	70.82
07	61.40
08	56.46
09	48.57
10	41.81
11	41.67
12	43.05
13	40.64
14	34.01
15	29.41
16	24.40
17	22.24
18	19.75
19	18.29
20	17.10
21	15.27
22	14.95
23	13.50
24	11.97
25	12.85
26	12.52
27	11.75
28	11.16
29	10.29
30	10.52
31	10.93
32	10.04
33	9.51
34	10.14
35	9.87
36	10.61
37	9.95
38	9.70
39	9.86
40	9.36
41	9.49
42	9.30
43	10.01
44	9.69
45	9.80
46	10.70
47	11.43
48	11.39
49	11.58
50	10.84
51	11.67
52	10.90
53	12.10
54	11.52
55	11.36
56	12.40
57	12.40
58	12.78
59	11.81
60	11.29
61	8.50
62	7.67
63	6.18
64	5.04
65	4.33
66	3.54
67	4.49
68	6.24
69	11.10
70	19.60
71	30.46
72	40.58
73	43.92
74	37.06
75	26.71
76	16.88
77	10.03
78	5.73
79	3.18
80	1.68
81	1.01
82	0.58
83	0.44
84	0.23
85	0.17
86	0.14
87	0
88	0
89	0
90	0
91	0
92	0
93	0
94	0
95	0
96	0
97	0
98	0
99	0


COUNTS PER MINUTE PER 20 KEV CHANNEL
1000
100
1.0
0.1
1.46
SAMPLE: K40 STANDARD
ACTIVITY: 209320 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO 1 ANALYZER: 400 V
DATE: 9/17/63
COUNTING TIME: 100 MIN
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
MEV ENERGY

Potassium-40 DECAY SCHEME 11/26/63



K^{40} EFFICIENCIES
9-17-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 209320 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in Channel 73}}{\text{dpm}} = \frac{43.92}{209320} = 0.000209$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in Channels 70-76}}{\text{dpm}} = \frac{215.21}{209320} = 0.00103$$

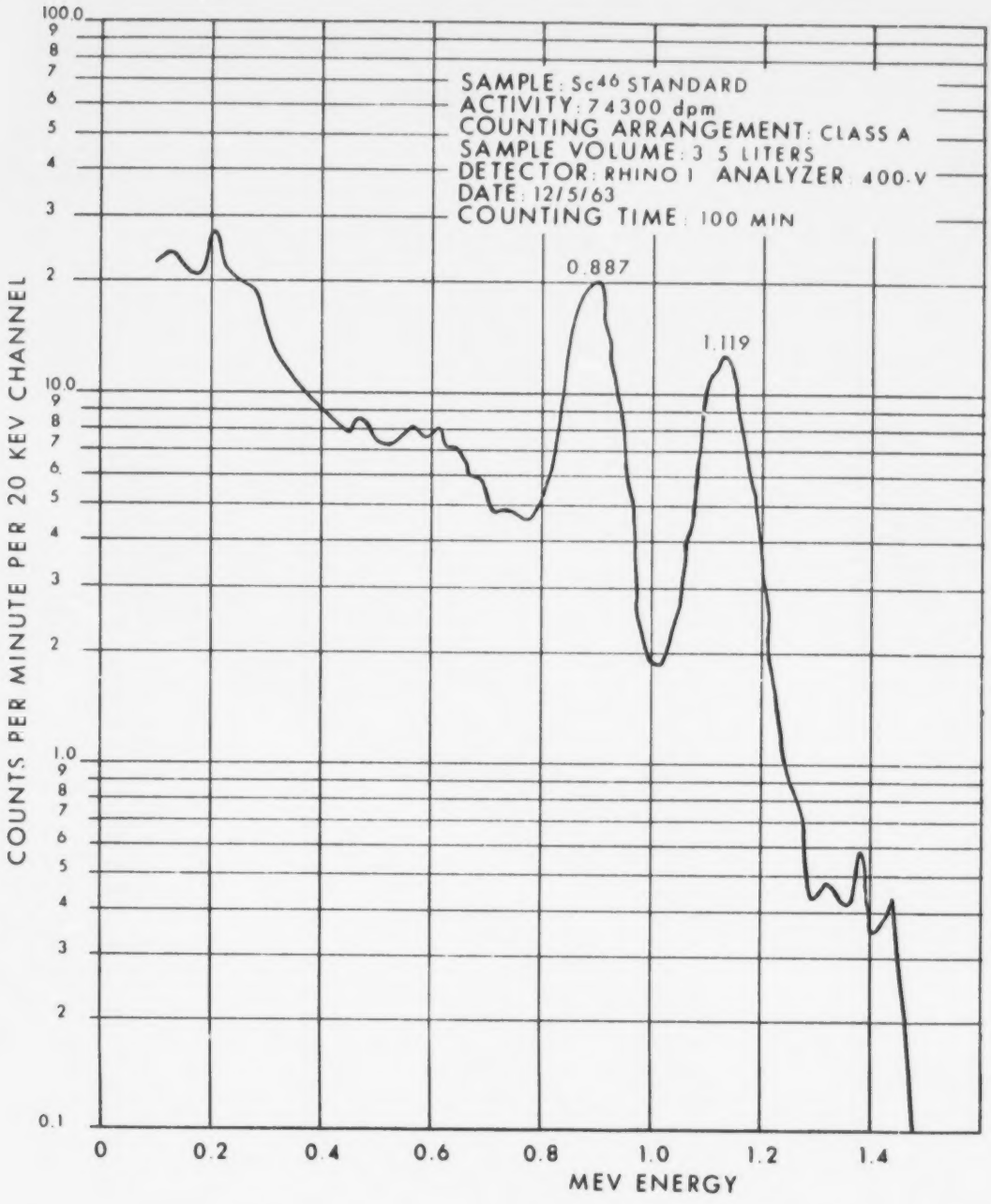
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 6 -99}}{\text{dpm}} = \frac{1310.49}{209320} = 0.00626$$

Sc^{46} STANDARD
12-5-63

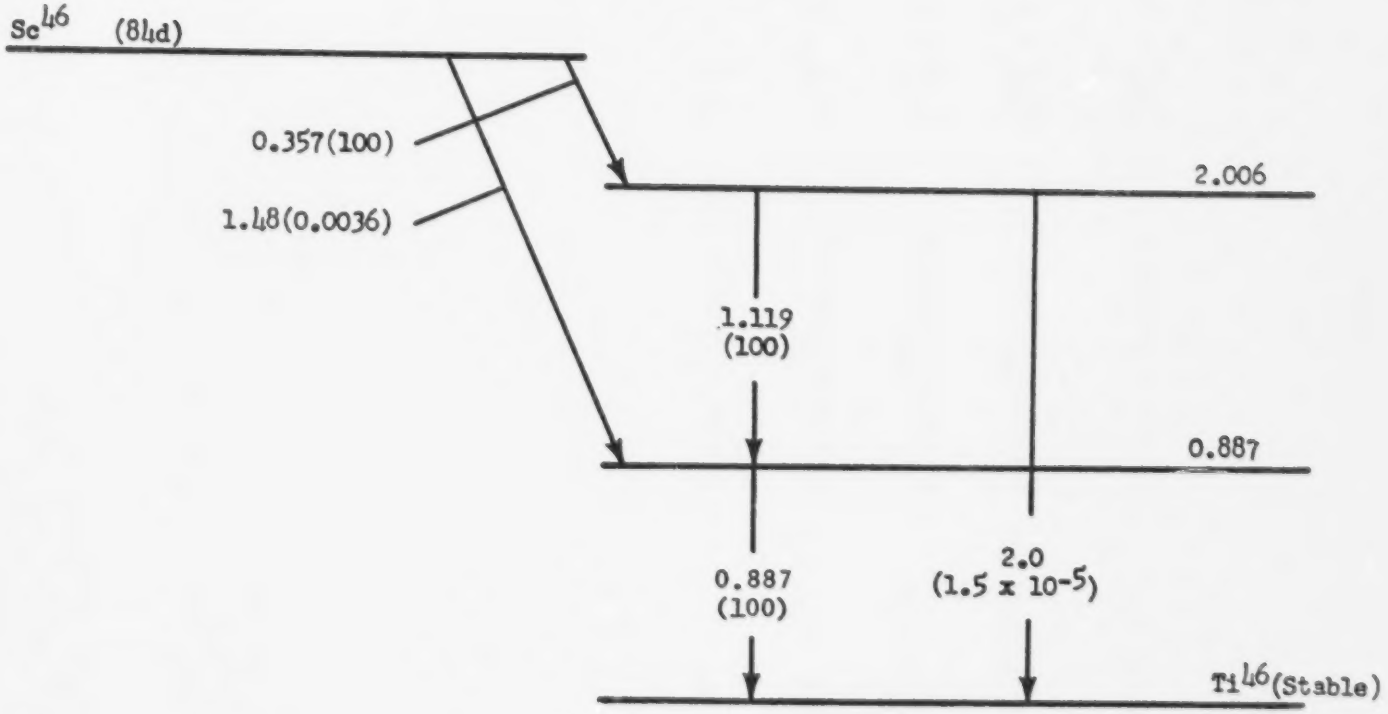
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 74,300 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
05	22.08
06	23.24
07	22.52
08	21.47
09	20.80
10	26.30
11	21.64
12	19.97
13	19.39
14	18.29
15	13.85
16	12.18
17	11.03
18	9.78
19	9.49
20	8.47
21	8.06
22	7.80
23	8.42
24	7.63
25	7.28
26	7.19
27	7.44
28	7.99
29	7.50
30	7.99
31	6.96
32	6.88
33	5.97
34	5.81
35	4.77
36	4.93
37	4.73
38	4.53
39	4.81
40	5.52
41	7.32
42	11.96
43	17.72
44	19.03
45	16.84
46	10.93
47	5.98
48	3.57
49	1.92
50	1.82
51	2.19
52	3.15
53	5.63
54	9.52
55	11.37
56	11.92
57	9.18
58	6.10
59	3.77
60	1.78
61	1.17
62	0.90
63	0.65
64	0.44
65	0.48
66	0.44
67	0.42
68	0.60
69	0.36
70	0.37
71	0.43
72	0.27
73	0.20
74	0.00


SAMPLE: Sc46 STANDARD
ACTIVITY: 74300 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 12/5/63
COUNTING TIME: 100 MIN
0.887
1.119
COUNTS PER MINUTE PER 20 KEV CHANNEL
100.0
10.0
1.0
0.1
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
MEV ENERGY

Scandium-46 DECAY SCHEME December 23, 1963



Sc^{46} EFFICIENCIES
12-5-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 74,300 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.}_{(0.887)} = \frac{\Sigma \text{ counts in Channel 44}}{\text{dpm}} = \frac{19.03}{74300} = 0.000256$$

$$\text{Total Photopeak Eff.}_{(0.887)} = \frac{\Sigma \text{ counts in Channels 41-47}}{\text{dpm}} = \frac{89.78}{74300} = 0.00121$$

$$\text{Total Peak Eff.}_{(1.119)} = \frac{\Sigma \text{ counts in Channel 56}}{\text{dpm}} = \frac{11.92}{74300} = 0.000160$$

$$\text{Total Photopeak Eff.}_{(1.119)} = \frac{\Sigma \text{ counts in Channels 52-60}}{\text{dpm}} = \frac{62.42}{74300} = 0.000840$$

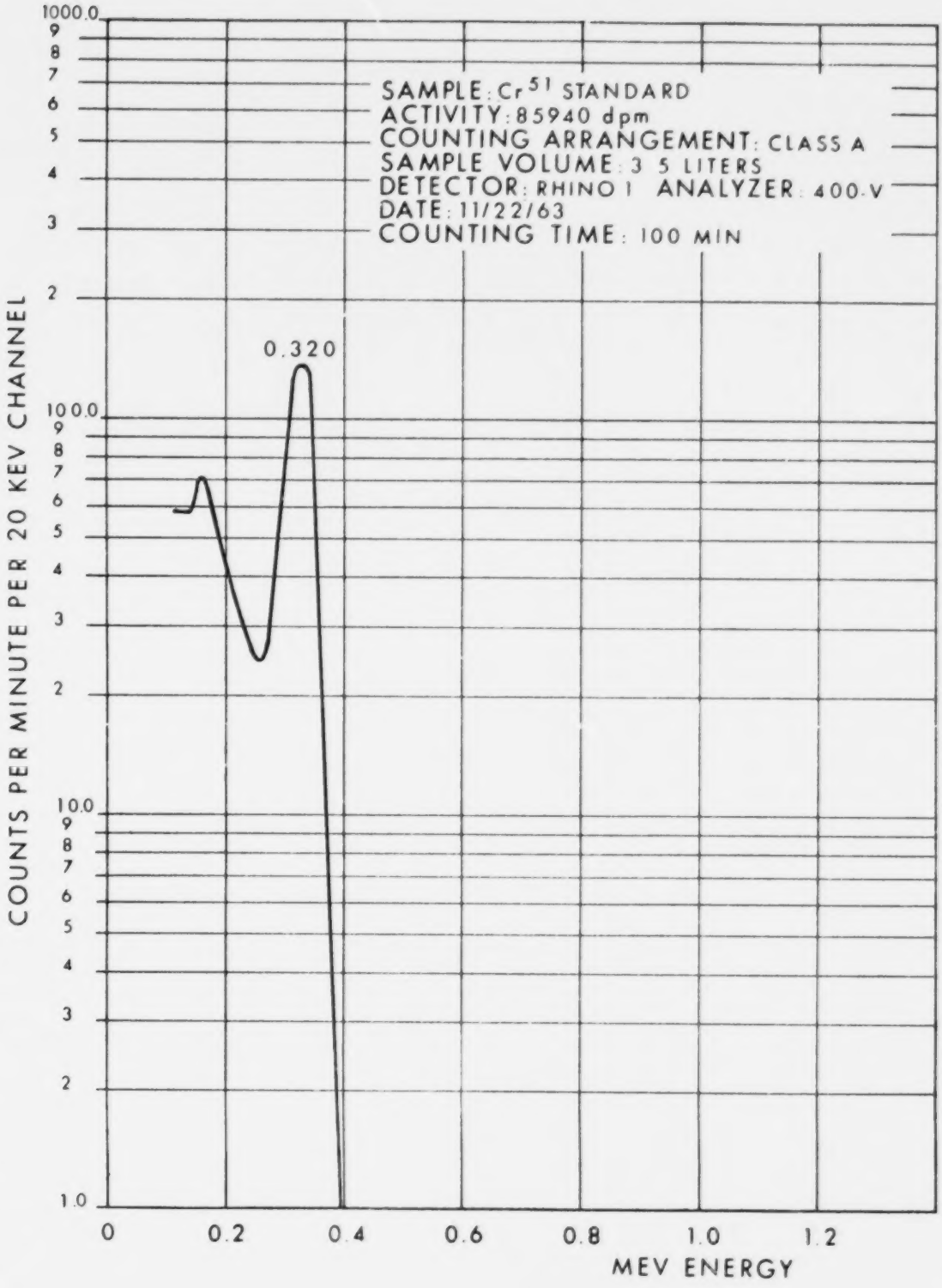
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{581.14}{74300} = 0.00782$$

Cr^{51} STANDARD
11-22-63

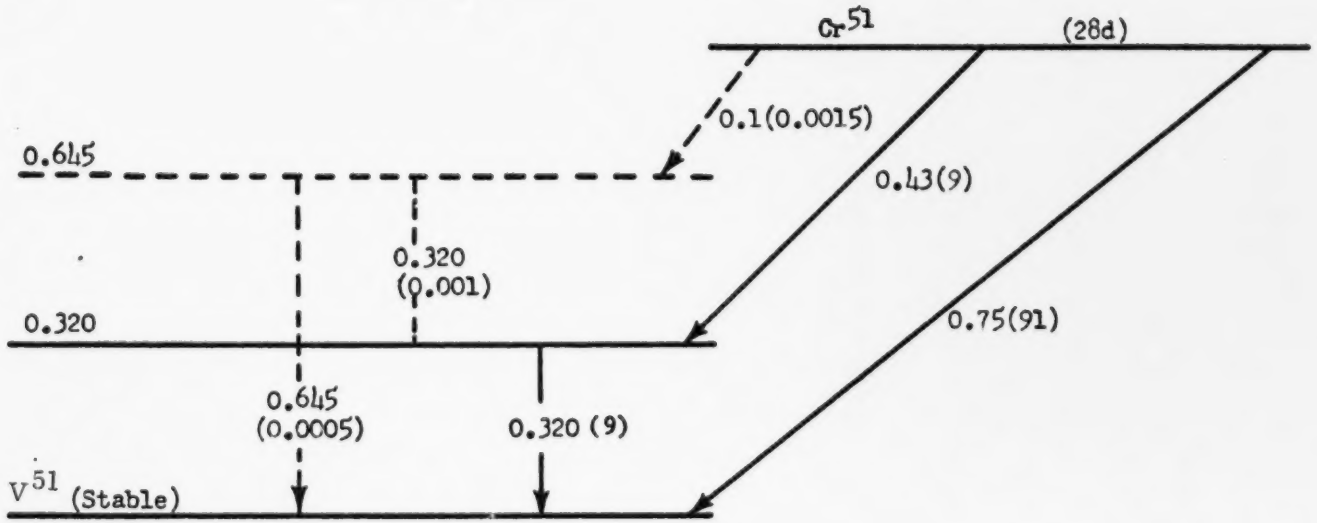
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 85,940 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
06	58.84
07	58.39
08	70.68
09	57.76
10	40.81
11	31.07
12	26.91
13	24.09
14	35.30
15	85.98
16	132.85
17	82.43
18	23.20
19	4.72
20	0.95
21	0.35
22	0.28


SAMPLE: Cr51 STANDARD
ACTIVITY: 85940 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 11/22/63
COUNTING TIME: 100 MIN
0.320
COUNTS PER MINUTE PER 20 KEV CHANNEL
1000.0
100.0
10.0
1.0
0
0.2
0.4
0.6
0.8
1.0
1.2
MEV ENERGY

Chromium 51 DECAY SCHEME 12/12/63



Cr^{51} EFFICIENCIES
11-22-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 85,940 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in Channel 16}}{\text{dpm}} = \frac{132.85}{85940} = 0.00155$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in Channels 14-18}}{\text{dpm}} = \frac{359.76}{85940} = 0.00419$$

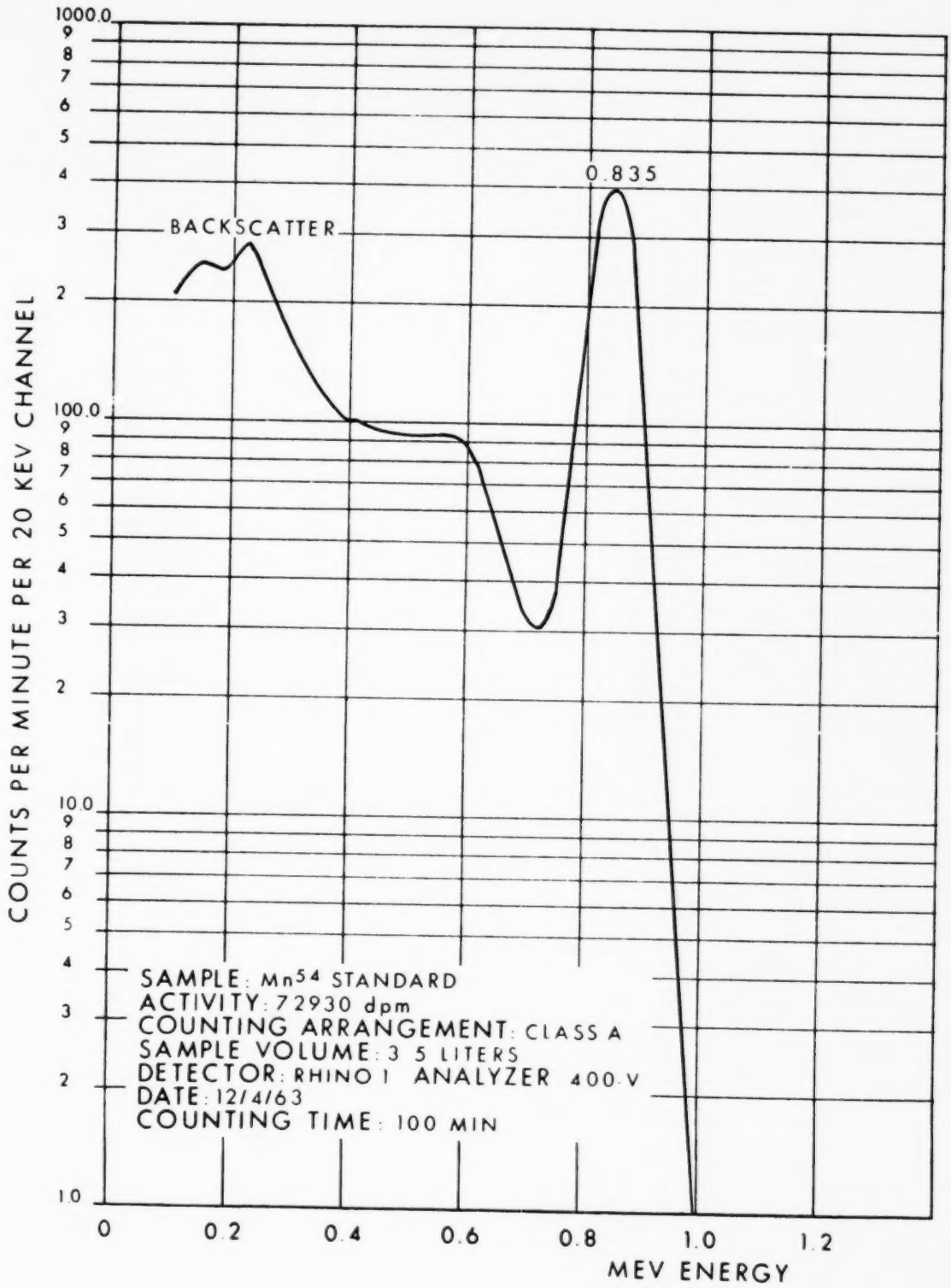
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{734.61}{85940} = 0.00855$$

Mn^{54} STANDARD
12-4-63

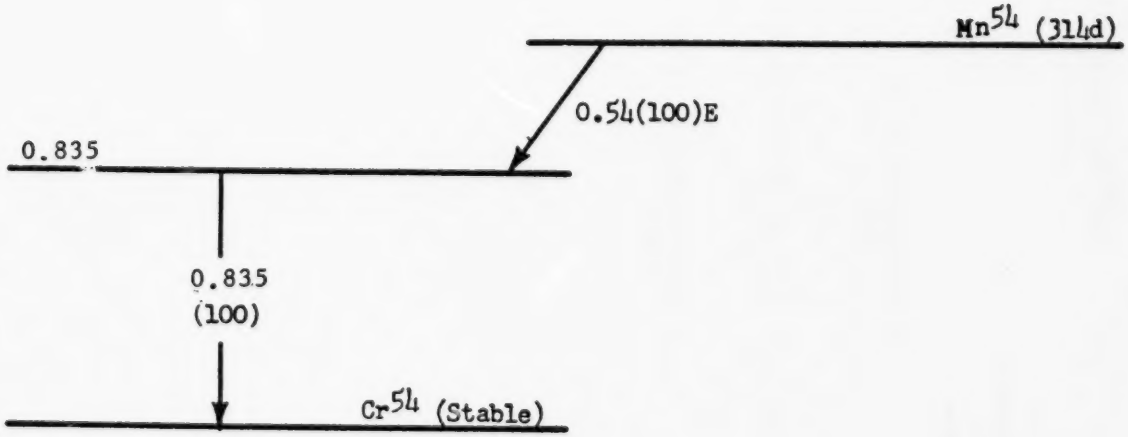
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 72930 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
05	210.90	29	91.05
06	237.98	30	82.84
07	248.95	31	66.98
08	249.82	32	54.47
09	236.08	33	42.48
10	263.07	34	35.84
11	280.83	35	31.41
12	254.75	36	30.05
13	208.48	37	36.80
14	177.44	38	65.16
15	150.23	39	142.34
16	134.74	40	272.35
17	120.37	41	372.52
18	115.78	42	379.92
19	104.70	43	278.04
20	101.73	44	149.40
21	98.05	45	69.18
22	96.01	46	28.42
23	93.99	47	11.92
24	92.89	48	5.37
25	93.08	49	1.82
26	92.71	50	0.98
27	92.85	51	0.26
28	92.98	52	0.00


1000.0
100.0
10.0
1.0
COUNTS PER MINUTE PER 20 KEV CHANNEL
BACKSCATTER
0.835
SAMPLE: Mn54 STANDARD
ACTIVITY: 72930 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER 400-V
DATE: 12/4/63
COUNTING TIME: 100 MIN
0
0.2
0.4
0.6
0.8
1.0
1.2
MEV ENERGY

Manganese-54 DECAY SCHEME 12/12/63



Mn^{54} EFFICIENCIES
12-4-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 72930 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in Channel 42}}{\text{dpm}} = \frac{379.92}{72930} = 0.00521$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in Channels 38-45}}{\text{dpm}} = \frac{1728.91}{72930} = 0.0237$$

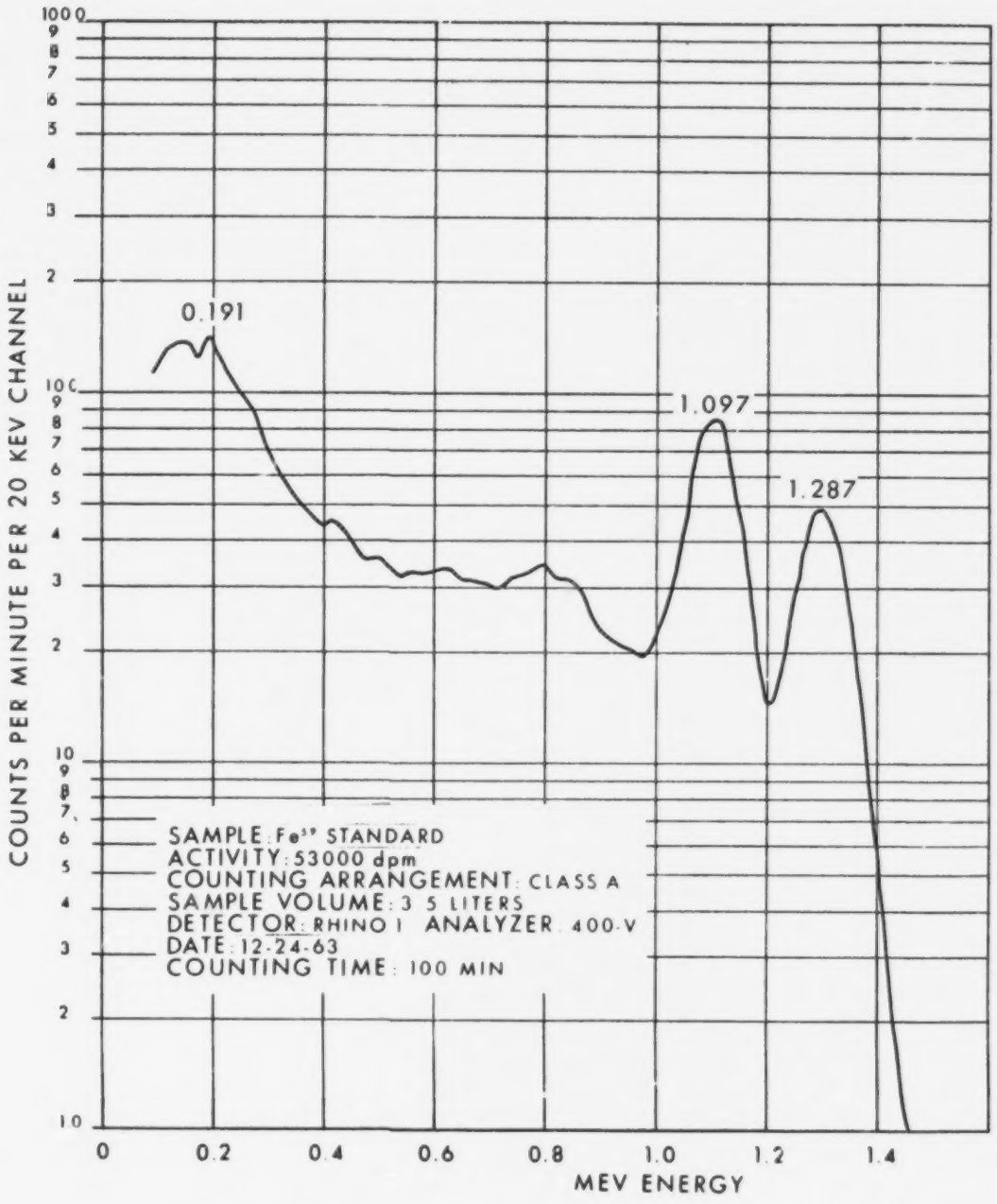
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{6055.53}{72930} = 0.0830$$

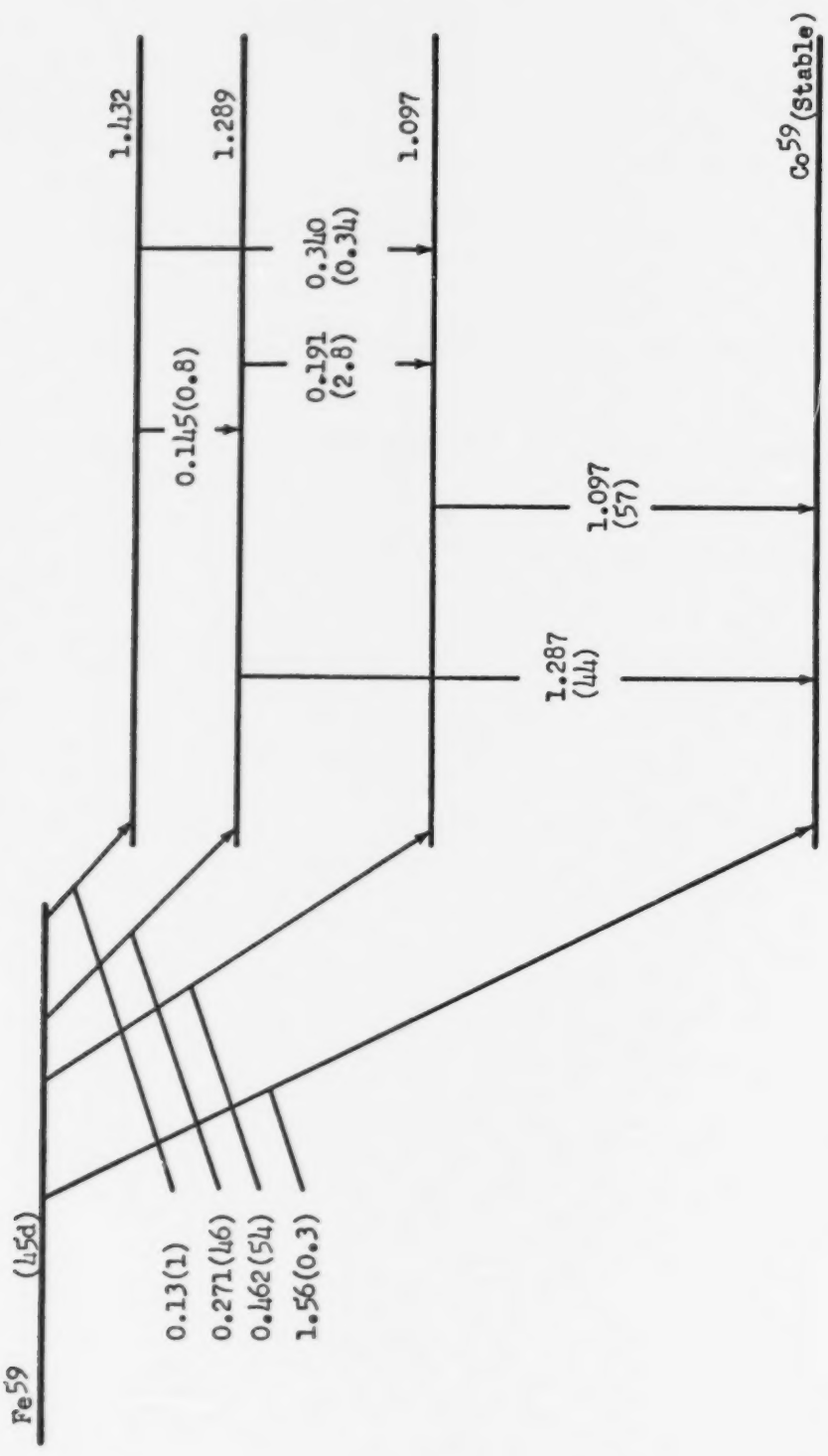
Fe^{59} STANDARD
12-24-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 53,000 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
05	110.35	43	30.35
06	127.34	44	25.62
07	131.64	45	22.90
08	132.14	46	21.98
09	121.88	47	20.76
10	137.90	48	20.35
11	121.28	49	19.60
12	109.92	50	22.16
13	97.51	51	27.08
14	87.30	52	38.74
15	71.86	53	59.34
16	62.77	54	78.60
17	56.01	55	84.62
18	51.46	56	75.66
19	46.80	57	52.31
20	43.79	58	32.12
21	44.35	59	20.03
22	42.32	60	14.54
23	38.07	61	17.14
24	35.18	62	25.66
25	35.26	63	38.16
26	33.92	64	48.04
27	31.86	65	47.77
28	32.44	66	40.32
29	32.26	67	27.43
30	32.58	68	17.15
31	33.21	69	9.64
32	32.23	70	4.97
33	30.83	71	2.62
34	30.45	72	1.41
35	30.05	73	1.00
36	29.74	74	0.55
37	31.57	75	0.52
38	31.92	76	0.43
39	32.07	77	0.10
40	33.68	78	0.00
41	31.76	79	0.00
42	31.66		


COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
0.191
1.097
1.287
SAMPLE: Fe55 STANDARD
ACTIVITY: 53000 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 12-24-63
COUNTING TIME: 100 MIN


Iron 59 DECAY SCHEME
1/4/64
Fe59
(45d)
0.13(1)
0.271(46)
0.462(54)
1.56(0.3)
1.432
1.289
1.097
0.145(0.8)
0.192
(2.8)
0.340
(0.34)
1.287
(44)
1.097
(57)
Co59(Stable)

Fe^{59} EFFICIENCIES

12-24-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 53,000 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.}_{(1.097)} = \frac{\Sigma \text{ counts in Channel 55}}{\text{dpm}} = \frac{84.62}{53000} = 0.00160$$

$$\text{Total Photopeak Eff.}_{(1.097)} = \frac{\Sigma \text{ counts in Channels 52-58}}{\text{dpm}} = \frac{421.39}{53000} = 0.00795$$

$$\text{Total Peak Eff.}_{(1.287)} = \frac{\Sigma \text{ counts in Channel 64}}{\text{dpm}} = \frac{48.04}{53000} = 0.000906$$

$$\text{Total Photopeak Eff.}_{(1.287)} = \frac{\Sigma \text{ counts in Channels 62-67}}{\text{dpm}} = \frac{227.38}{53000} = 0.00429$$

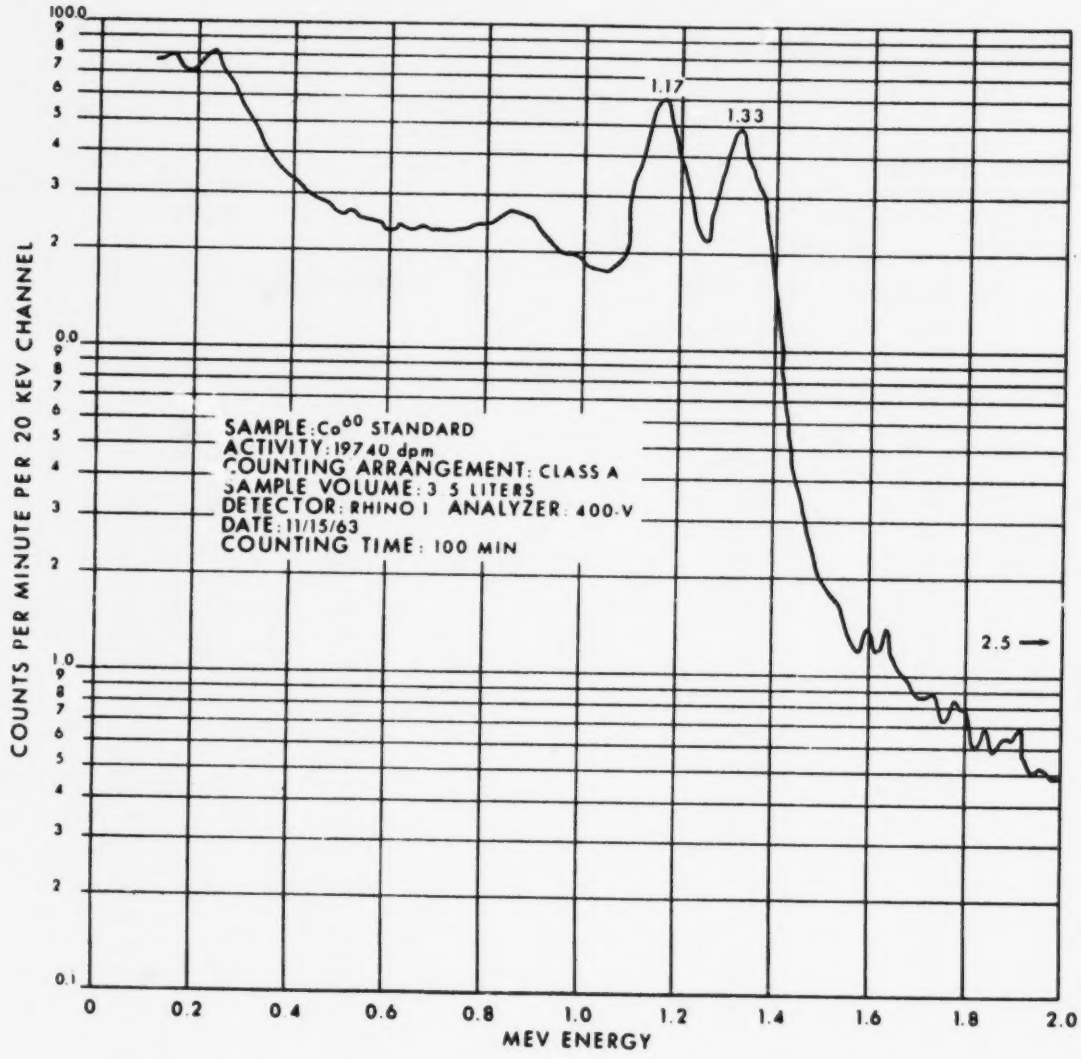
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{3197.03}{53000} = 0.0603$$

Co^{60} STANDARD
11-15-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 19,740 dpm

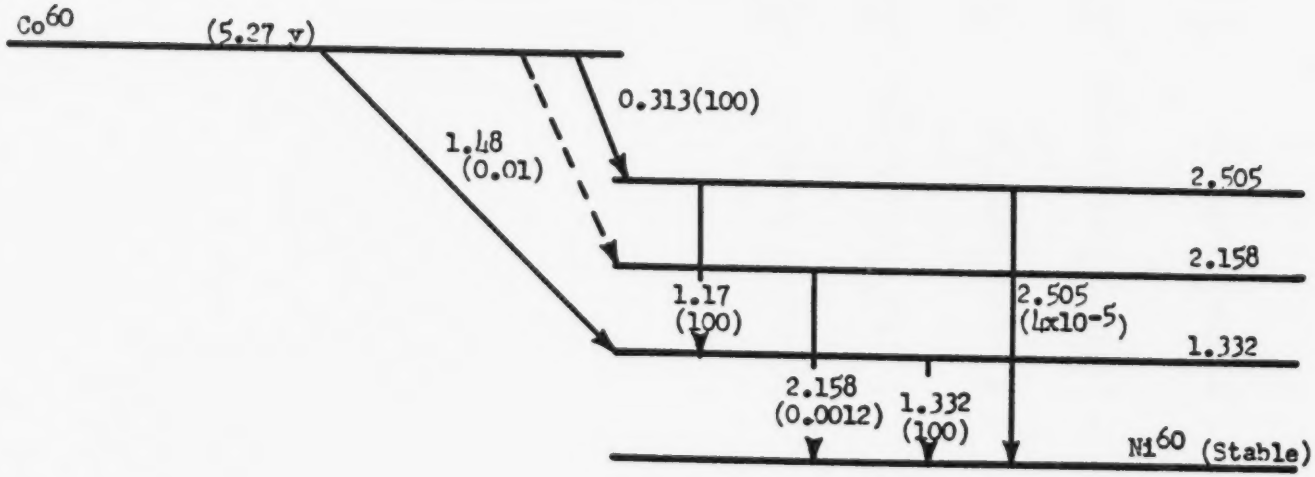
20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
06	76.46	53	16.93
07	79.16	54	17.74
08	79.02	55	22.74
09	70.22	56	33.35
10	71.94	57	45.88
11	77.85	58	55.50
12	80.10	59	52.71
13	70.74	60	41.86
14	61.36	61	30.00
15	52.90	62	22.09
16	46.60	63	21.39
17	40.72	64	28.28
18	37.27	65	37.22
19	34.77	66	45.09
20	33.40	67	41.60
21	30.68	68	33.97
22	28.98	69	22.99
23	28.38	70	14.51
24	27.08	71	8.50
25	25.62	72	4.84
26	26.09	73	3.17
27	24.17	74	2.53
28	24.43	75	1.99
29	24.08	76	1.76
30	22.45	77	1.65
31	23.53	78	1.34
32	22.66	79	1.19
33	23.17	80	1.38
34	23.08	81	1.18
35	22.83	82	1.41
36	22.81	83	1.06
37	22.80	84	0.99
38	22.96	85	0.88
39	23.46	86	0.84
40	23.28	87	0.87
41	24.32	88	0.72
42	25.02	89	0.82
43	25.20	90	0.77
44	25.79	91	0.59
45	24.11	92	0.68
46	22.54	93	0.58
47	20.77	94	0.63
48	19.81	95	0.62
49	19.13	96	0.70
50	18.48	97	0.50
51	17.36	98	0.51
52	17.16	99	0.49


COUNTS PER MINUTE PER 20 KEV CHANNEL
100.0
10.0
1.0
0.1
1.17
1.33
2.5
SAMPLE: Co60 STANDARD
ACTIVITY: 19740 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 11/15/63
COUNTING TIME: 100 MIN
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
MEV ENERGY

Cobalt-60 DECAY SCHEME

11/29/63



Co^{60} EFFICIENCIES
11-15-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 19,740 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $_{(1,17)} = \frac{\Sigma \text{ counts in Channel 58}}{\text{dpm}} = \frac{55.50}{19,740} = 0.00281$

Total Photopeak Eff. $_{(1,17)} = \frac{\Sigma \text{ counts in Channels 55-61}}{\text{dpm}} = \frac{282.04}{19,740} = 0.0143$

Total Peak Eff. $_{(1,33)} = \frac{\Sigma \text{ counts in Channel 66}}{\text{dpm}} = \frac{45.09}{19,740} = 0.00258$

Total Photopeak Eff. $_{(1,33)} = \frac{\Sigma \text{ counts in Channels 64-69}}{\text{dpm}} = \frac{209.16}{19,740} = 0.0106$

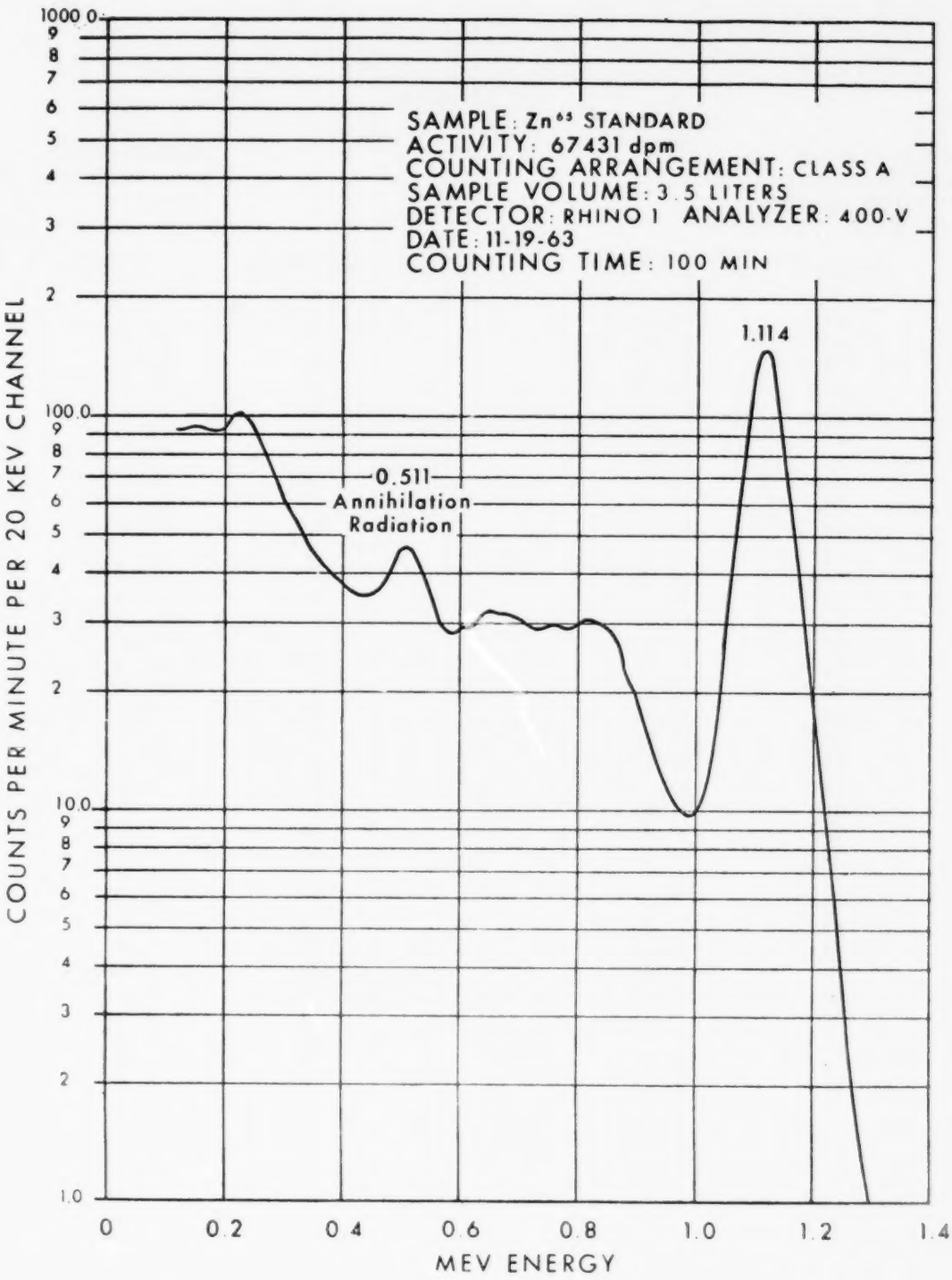
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{2291.78}{19,740} = 0.161$

Zn^{65} STANDARD
11-19-63

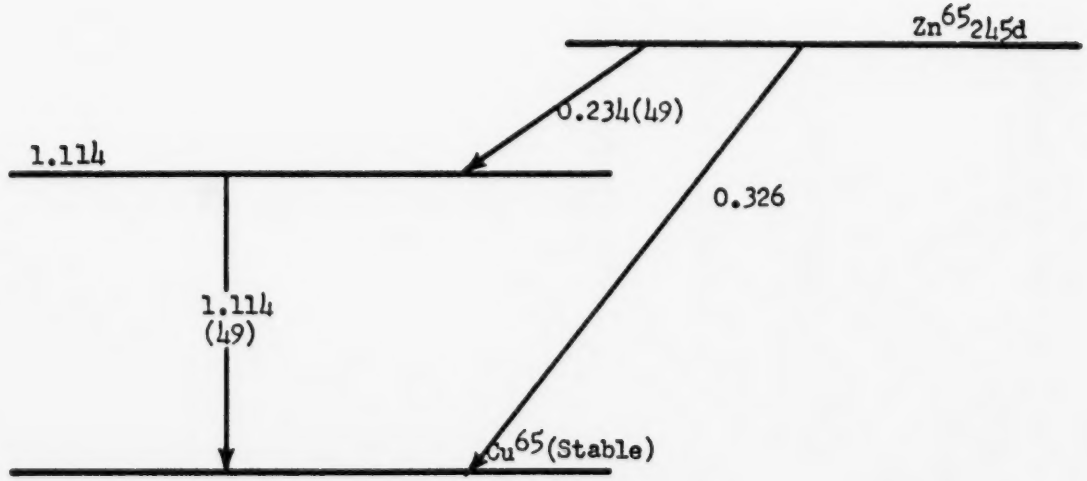
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 67,431 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
06	92.77	41	30.37
07	93.83	42	29.79
08	94.21	43	27.77
09	91.11	44	22.82
10	92.64	45	18.76
11	101.83	46	14.84
12	99.87	47	12.24
13	86.51	48	10.71
14	73.26	49	9.62
15	60.76	50	10.78
16	54.11	51	15.56
17	47.48	52	30.97
18	43.17	53	58.99
19	40.91	54	93.43
20	38.54	55	114.76
21	35.65	56	112.30
22	35.29	57	88.14
23	36.27	58	59.00
24	40.25	59	31.51
25	46.85	60	16.74
26	46.06	61	7.76
27	39.17	62	4.22
28	31.84	63	1.82
29	28.02	64	1.35
30	29.16	65	0.77
31	29.37	66	0.19
32	32.54	67	0.04
33	31.78	68	0.03
34	31.88	69	0.00
35	30.46	70	0.00
36	29.15	71	0.00
37	29.22	72	0.00
38	29.79	73	0.00
39	29.27	74	0.00
40	30.51	75	0.00


SAMPLE: Zn⁶⁵ STANDARD
ACTIVITY: 67431 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3.5 LITERS
DETECTOR: RHINO 1 ANALYZER: 400-V
DATE: 11-19-63
COUNTING TIME: 100 MIN
1.114
0.511
Annihilation
Radiation
COUNTS PER MINUTE PER 20 KEV CHANNEL
1000.0
100.0
10.0
1.0
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
MEV ENERGY

Zinc 65 DECAY SCHEME 12/12/63



Zn^{65} EFFICIENCIES
11-19-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 67,431 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel } 55}{\text{dpm}} = \frac{114.76}{67431} = 0.00170$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels } 52\text{-}59}{\text{dpm}} = \frac{589.10}{67431} = 0.00874$

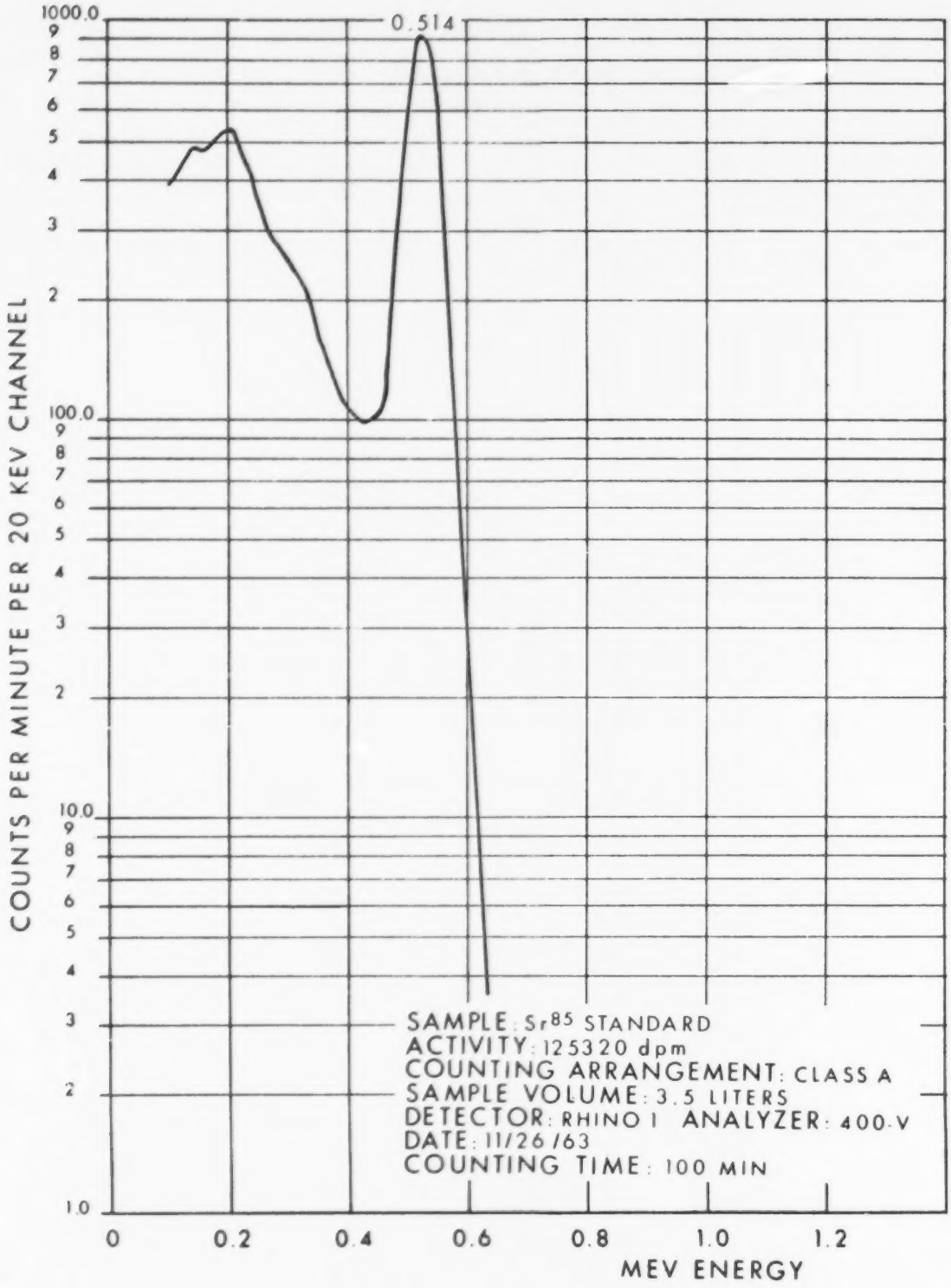
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels } 6\text{-}99}{\text{dpm}} = \frac{2608.81}{67431} = 0.0387$

Sr^{85} STANDARD
11-26-63

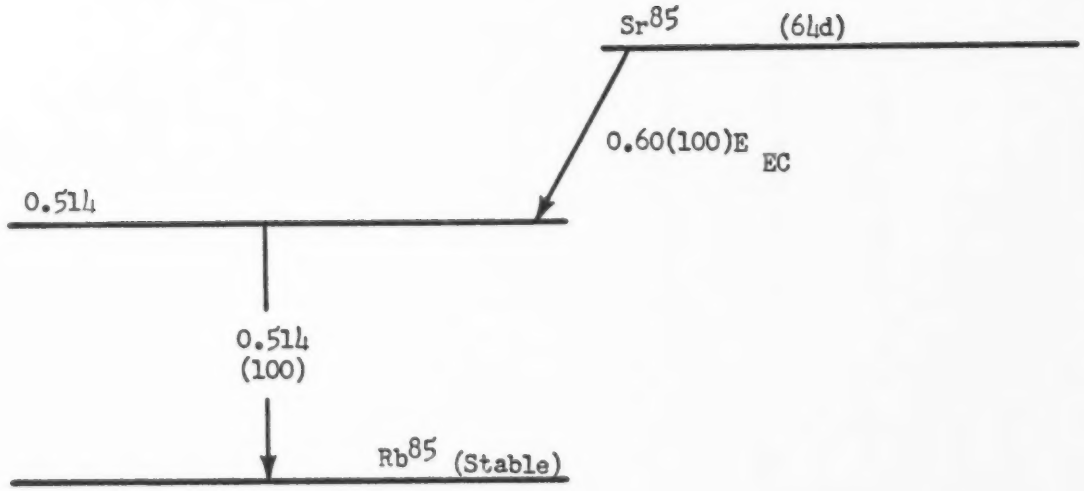
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 125,320 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
05	389.65
06	452.56
07	476.18
08	469.35
09	502.17
10	529.84
11	459.70
12	371.03
13	306.63
14	269.66
15	244.30
16	217.58
17	171.09
18	138.05
19	116.05
20	107.93
21	98.66
22	102.78
23	161.45
24	389.87
25	755.83
26	883.04
27	579.71
28	236.49
29	65.87
30	16.54
31	3.66
32	0.80
33	0.54
34	0.56
35	0.00
36	0.00


0.514
COUNTS PER MINUTE PER 20 KEV CHANNEL
1000.0
100.0
10.0
1.0
0
0.2
0.4
0.6
0.8
1.0
1.2
MEV ENERGY
SAMPLE: Sr85 STANDARD
ACTIVITY: 125320 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3.5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 11/26/63
COUNTING TIME: 100 MIN

Strontium 85 DECAY SCHEME 12/12/63



Sr^{85} EFFICIENCIES
11-26-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 125,320 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 26}}{\text{dpm}} = \frac{883.04}{125320} = 0.00705$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 23-28}}{\text{dpm}} = \frac{3006.39}{125320} = 0.0240$

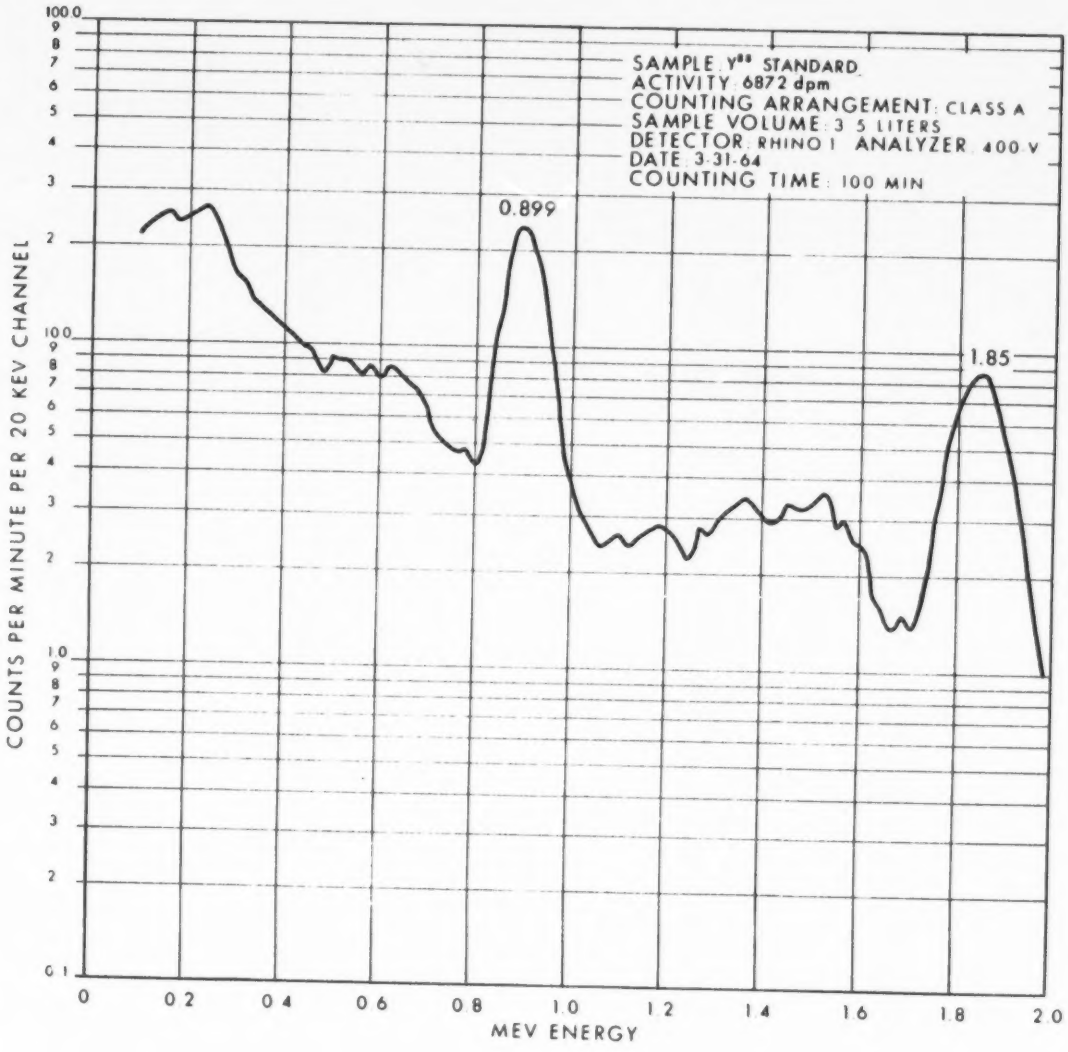
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{8517.57}{125320} = 0.0680$

Y^{88} STANDARD
3-31-64

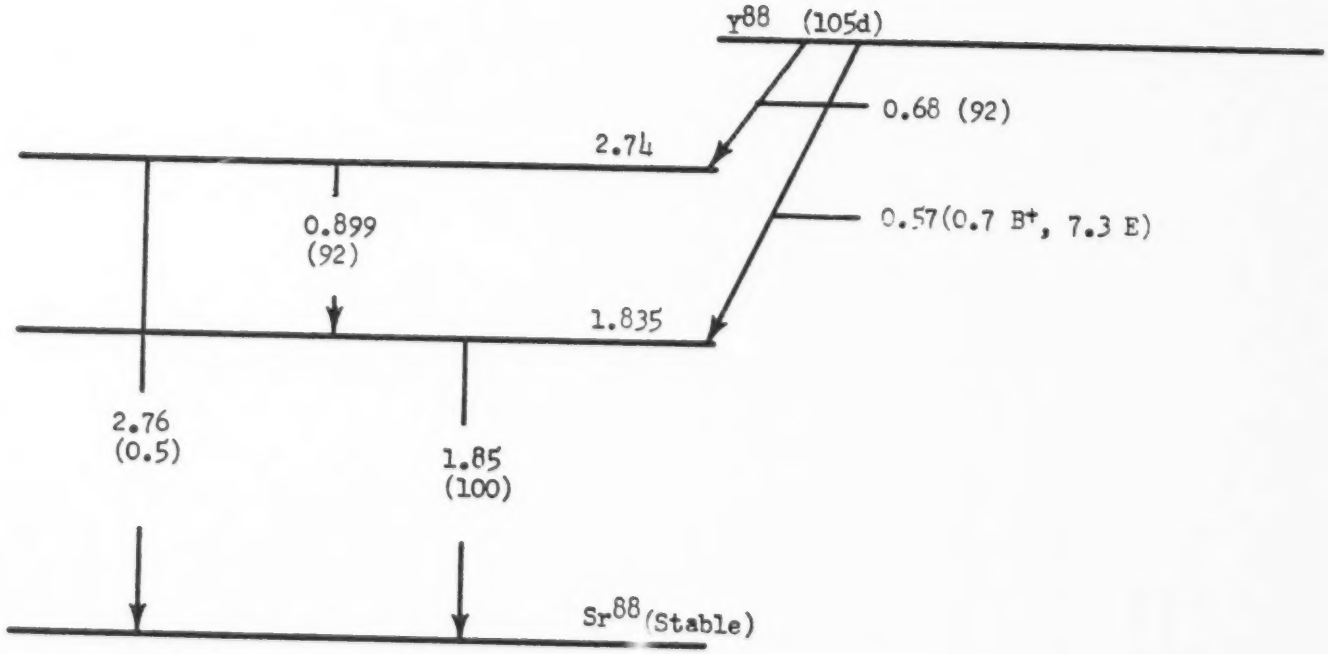
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liter
ACTIVITY: 6872 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
03	8.44	51	2.98
04	15.93	52	2.70
05	21.49	53	2.42
06	23.05	54	2.51
07	24.62	55	2.61
08	25.28	56	2.43
09	23.63	57	2.68
10	24.25	58	2.71
11	25.11	59	2.81
12	26.41	60	2.64
13	23.66	61	2.47
14	19.95	62	2.21
15	16.45	63	2.78
16	15.64	64	2.66
17	13.02	65	3.01
18	12.77	66	3.15
19	12.00	67	3.32
20	11.05	68	3.47
21	10.23	69	3.14
22	9.75	70	2.93
23	9.49	71	2.96
24	8.16	72	3.30
25	9.13	73	3.23
26	8.95	74	3.32
27	8.87	75	3.45
28	8.12	76	3.63
29	8.50	77	2.84
30	7.87	78	2.94
31	8.51	79	2.56
32	8.02	80	2.47
33	7.60	81	1.72
34	7.18	82	1.60
35	5.93	83	1.37
36	5.08	84	1.50
37	4.89	85	1.40
38	4.62	86	1.73
39	4.75	87	2.65
40	4.31	88	3.87
41	5.94	89	6.06
42	10.28	90	7.12
43	16.88	91	8.26
44	22.75	92	8.54
45	22.87	93	7.98
46	19.76	94	5.91
47	14.00	95	4.66
48	8.35	96	3.18
49	4.49	97	2.09
50	3.78	98	1.37
		99	1.00


SAMPLE: Y88 STANDARD
ACTIVITY: 6872 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO 1 ANALYZER: 400 V
DATE: 3-31-64
COUNTING TIME: 100 MIN
0.899
1.85
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
0
0 2
0 4
0 6
0 8
1.0
1 2
1 4
1 6
1 8
2 0

Yttrium-88 DECAY SCHEME 4/30/64



Y^{88} EFFICIENCIES
3-31-64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 6872 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.}_{(0.899)} = \frac{\Sigma \text{ counts in Channel 45}}{\text{dpm}} = \frac{22.87}{6872} = 0.00333$$

$$\text{Total Photopeak Eff.}_{(0.899)} = \frac{\Sigma \text{ counts in Channels 42-48}}{\text{dpm}} = \frac{114.89}{6872} = 0.0167$$

$$\text{Total Peak Eff.}_{(1.85)} = \frac{\Sigma \text{ counts in Channel 92}}{\text{dpm}} = \frac{8.54}{6872} = 0.00124$$

$$\text{Total Photopeak Eff.}_{(1.85)} = \frac{\Sigma \text{ counts in Channels 88-96}}{\text{dpm}} = \frac{55.58}{6872} = 0.00809$$

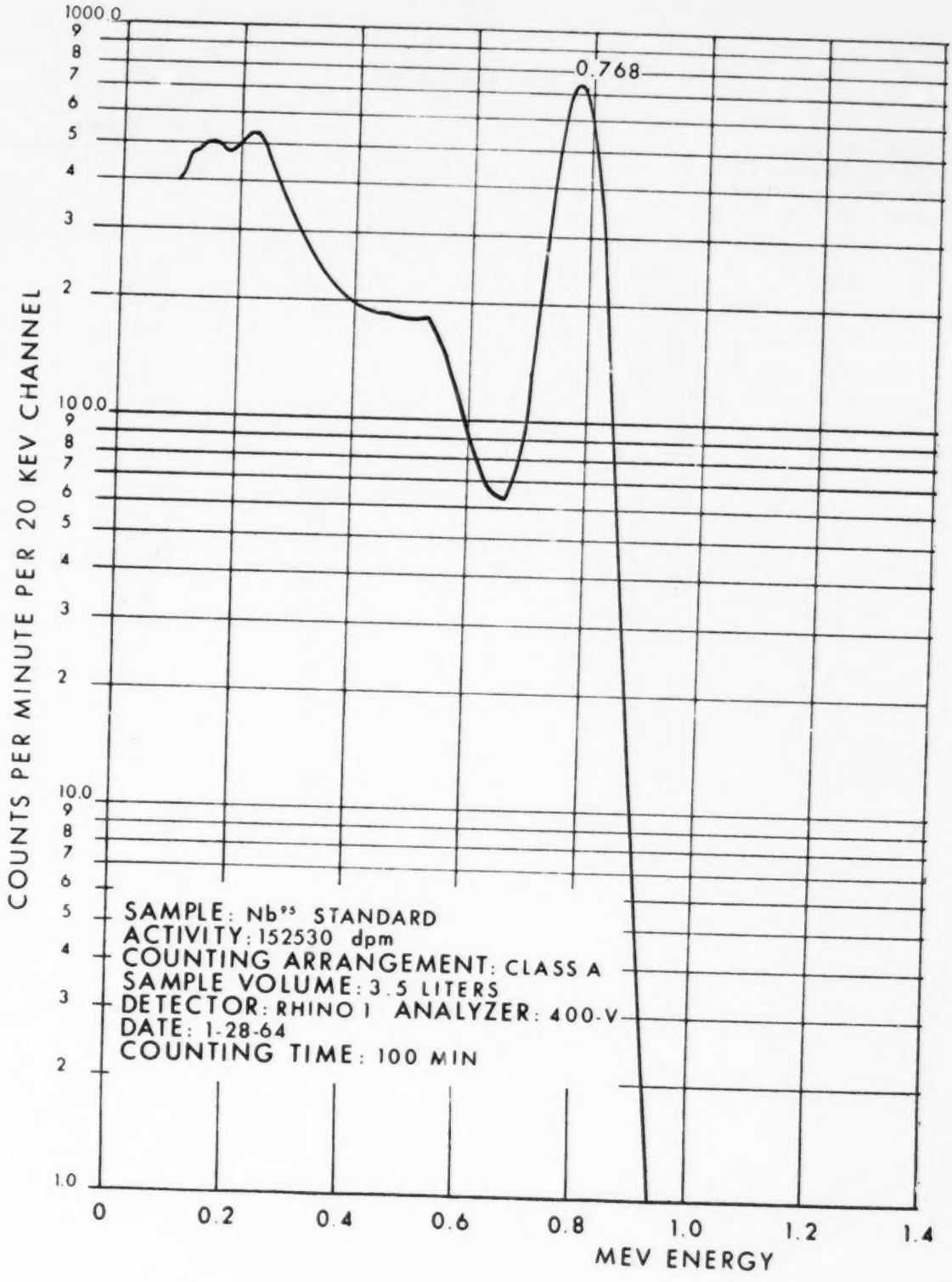
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 3-99}}{\text{dpm}} = \frac{780.15}{6872} = 0.114$$

Nb^{95} STANDARD
1-28-64

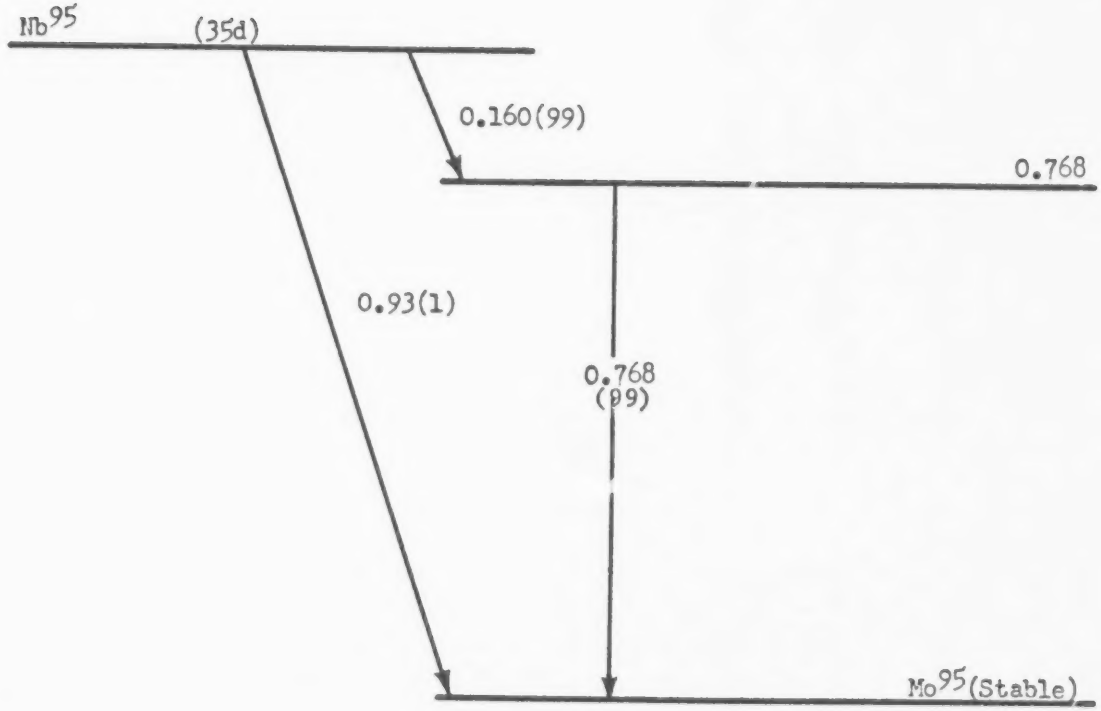
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 152,530 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
05	402.95
06	475.44
07	501.63
08	502.89
09	480.94
10	512.87
11	541.71
12	507.69
13	426.39
14	361.65
15	307.16
16	275.08
17	241.88
18	226.33
19	214.18
20	203.44
21	195.97
22	195.50
23	190.45
24	187.35
25	186.33
26	187.95
27	169.72
28	144.49
29	113.15
30	91.83
31	76.88
32	69.45
33	65.43
34	79.36
35	130.26
36	277.76
37	510.44
38	717.26
39	709.01
40	519.56
41	274.55
42	117.93
43	44.06
44	16.28
45	6.42
46	2.56
47	0.83
48	0.44
49	0.25
50	0.07
51	0.02
52	0.00


COUNTS PER MINUTE PER 20 KEV CHANNEL
1000.0
9
8
7
6
5
4
3
2
100.0
9
8
7
6
5
4
3
2
10.0
9
8
7
6
5
4
3
2
1.0
0.768
SAMPLE: Nb95 STANDARD
ACTIVITY: 152530 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3.5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 1-28-64
COUNTING TIME: 100 MIN
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
MEV ENERGY

Niobium-95 DECAY SCHEME 12/12/63



Nb^{95} EFFICIENCIES
1-28-64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 152,530 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 38}}{\text{dpm}} = \frac{717.26}{152,530} = 0.00470$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 35-42}}{\text{dpm}} = \frac{3256.77}{152,530} = 0.0214$

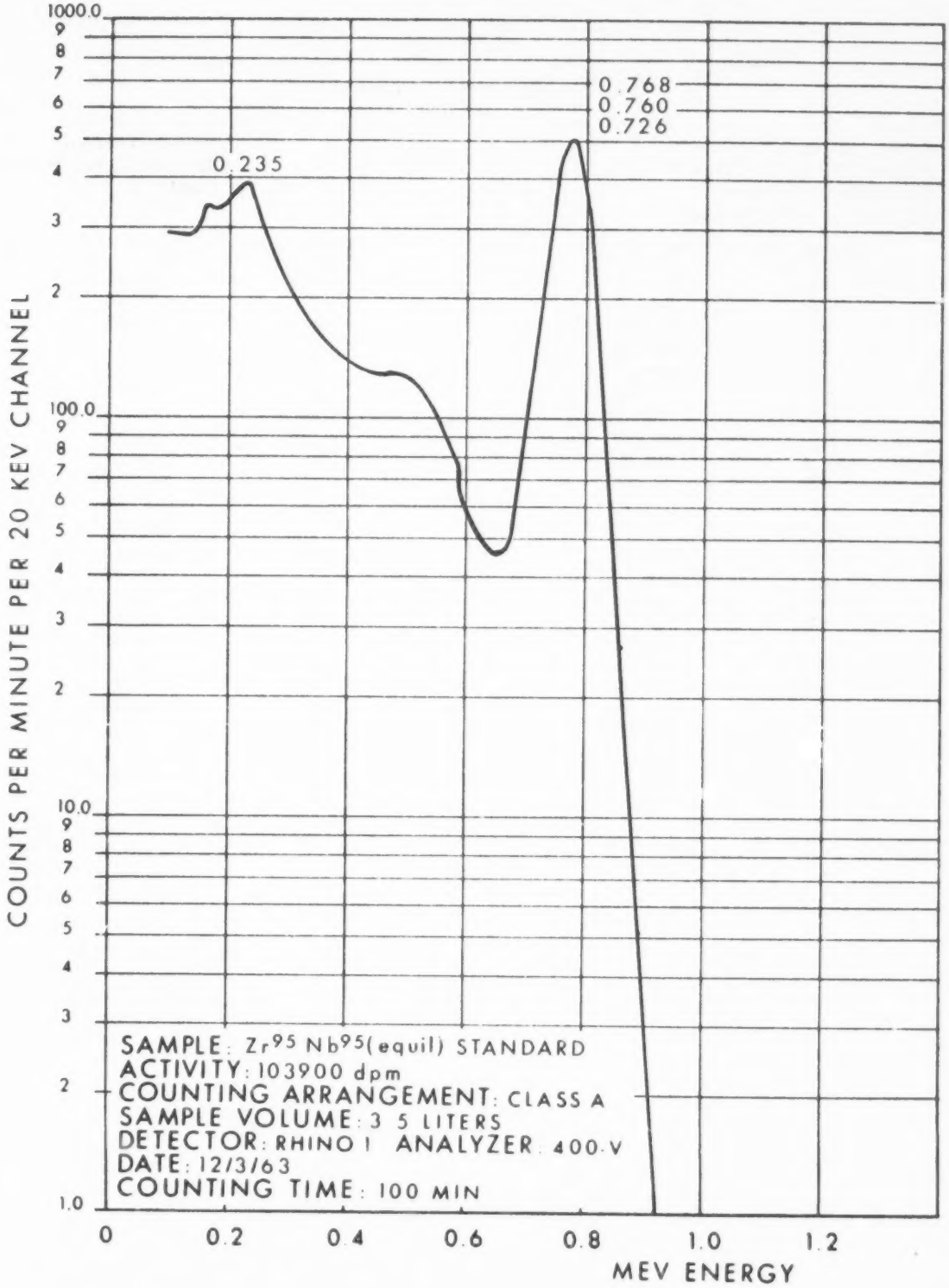
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{11,463.79}{152,530} = 0.0752$

Zr^{95} - Nb^{95} (equil) STANDARD
12-3-63

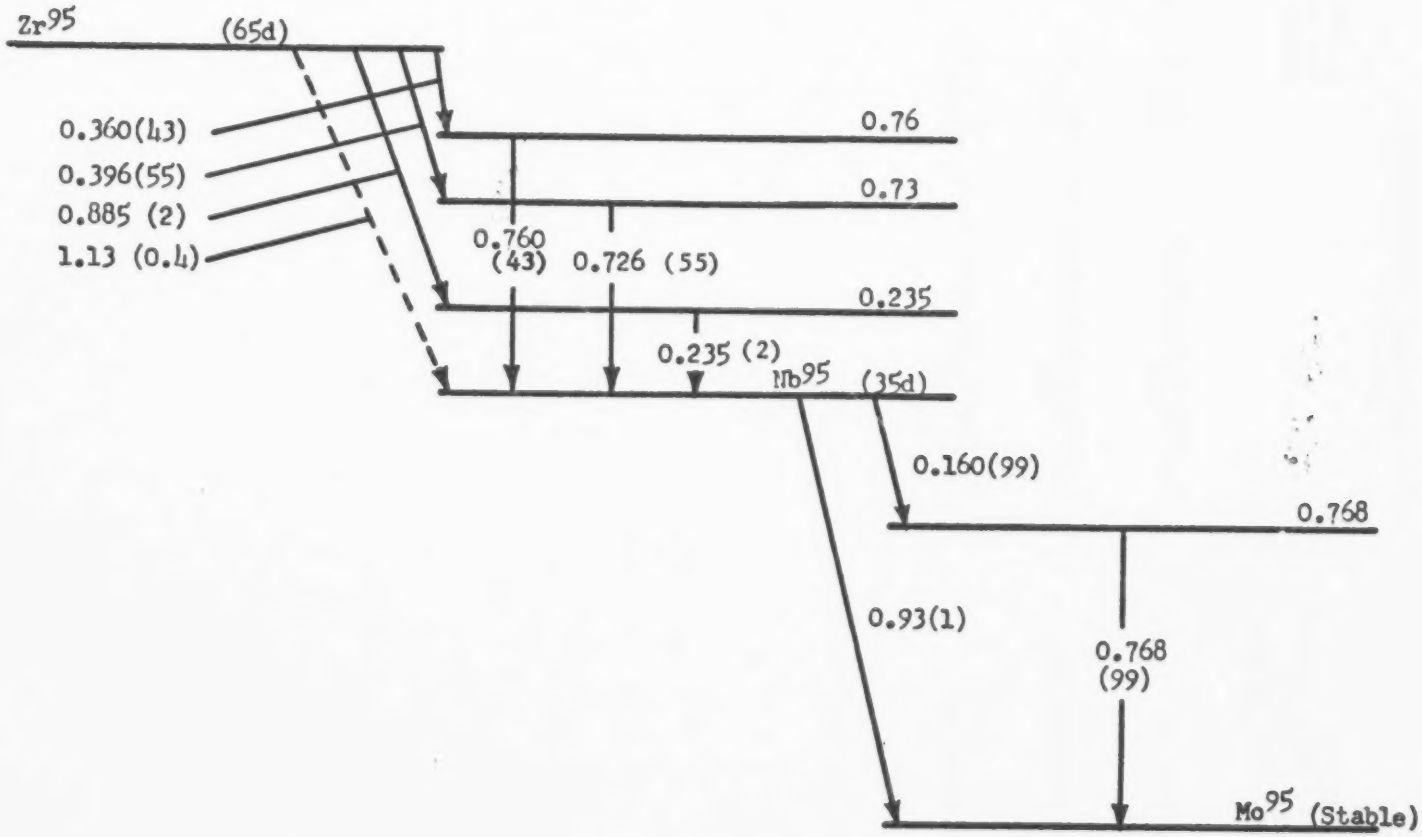
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 103,900 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
05	283.56	28	91.44
06	284.77	29	71.68
07	286.93	30	56.89
08	333.28	31	49.13
09	324.15	32	45.94
10	347.91	33	46.80
11	370.84	34	64.54
12	334.12	35	111.74
13	277.32	36	216.79
14	235.06	37	363.71
15	201.12	38	476.98
16	179.80	39	454.48
17	162.95	40	322.71
18	152.20	41	168.57
19	142.13	42	72.54
20	137.13	43	26.59
21	131.08	44	9.36
22	127.12	45	3.15
23	125.08	46	1.22
24	127.83	47	0.63
25	124.66	48	0.30
26	119.50	49	0.00
27	106.90	50	0.00


COUNTS PER MINUTE PER 20 KEV CHANNEL
1000.0
100.0
10.0
1.0
0.235
0.768
0.760
0.726
SAMPLE: Zr95 Nb95(equil) STANDARD
ACTIVITY: 103900 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400 V
DATE: 12/3/63
COUNTING TIME: 100 MIN
0
0.2
0.4
0.6
0.8
1.0
1.2
MEV ENERGY

Zirconium 95-Niobium 95 (equil) DECAY SCHEME 12/12/63



Zr^{95} - Nb^{95} (equil) EFFICIENCIES
12-3-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 103,900 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 38}}{\text{dpm}} = \frac{476.98}{103900} = 0.00459$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 34-42}}{\text{dpm}} = \frac{2252.06}{103900} = 0.0217$

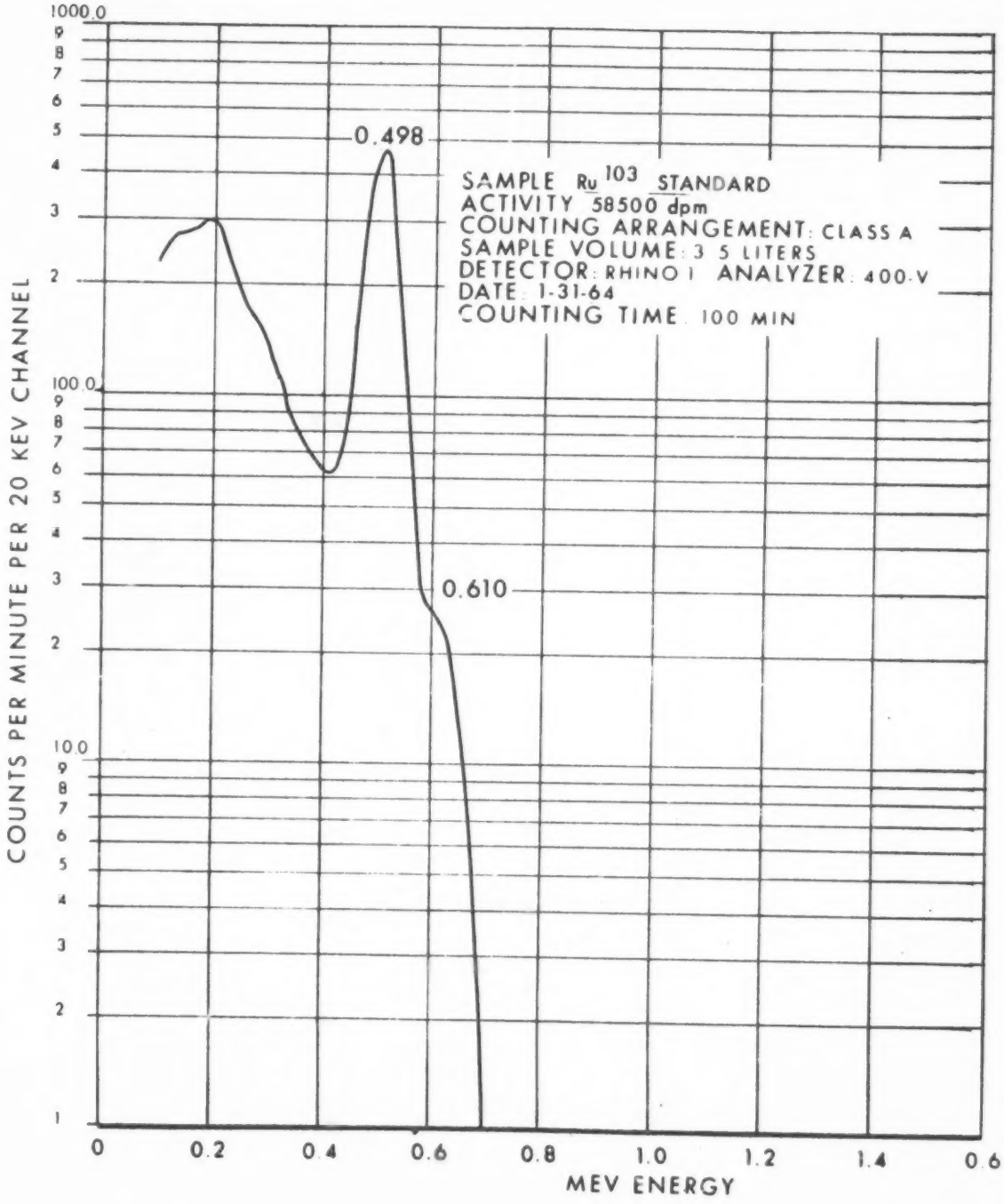
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{7570.43}{103900} = 0.0729$

Ru^{103} STANDARD
1-31-64

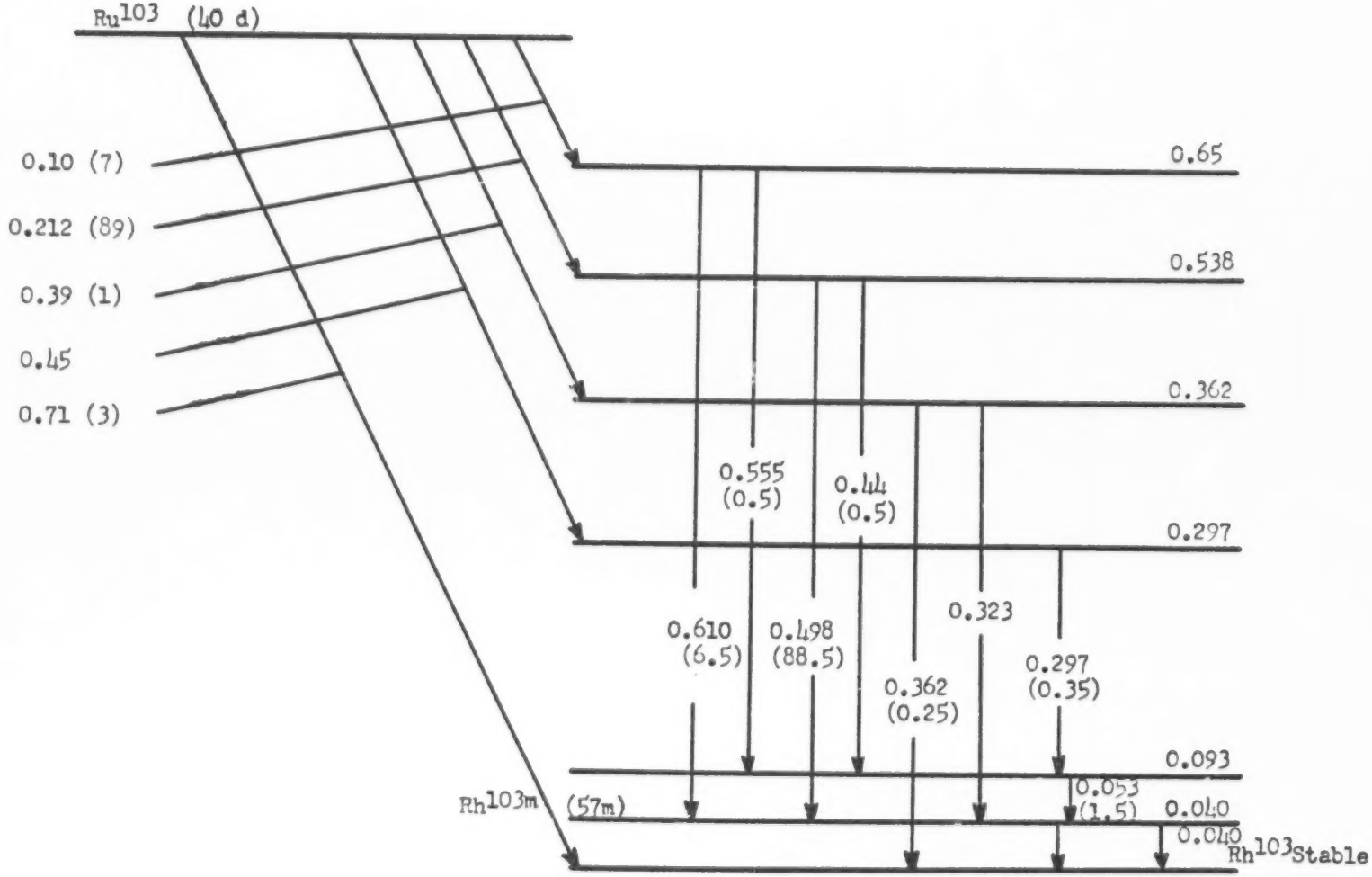
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 58500 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
05	225.53
06	263.02
07	268.15
08	270.84
09	294.43
10	294.22
11	249.42
12	200.33
13	169.88
14	150.99
15	129.53
16	109.69
17	86.83
18	74.16
19	66.60
20	61.54
21	62.93
22	89.80
23	195.22
24	372.20
25	446.57
26	339.56
27	162.37
28	59.64
29	28.05
30	25.53
31	22.10
32	14.21
33	7.30
34	2.93
35	0.81
36	0.48
37	0.23
38	0.20
39	0
40	0
41	0


1000.0
100.0
10.0
1
0.498
0.610
SAMPLE Ru 103 STANDARD
ACTIVITY 58500 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 1-31-64
COUNTING TIME: 100 MIN
COUNTS PER MINUTE PER 20 KEV CHANNEL
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.6
MEV ENERGY

RUTHENIUM-103 DECAY SCHEME 2/7/64



Ru^{103} EFFICIENCIES
1-31-64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 58500 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in Channel 25}}{\text{dpm}} = \frac{446.57}{58500} = 0.00763$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in Channels 22-28}}{\text{dpm}} = \frac{1665.36}{58500} = 0.0285$$

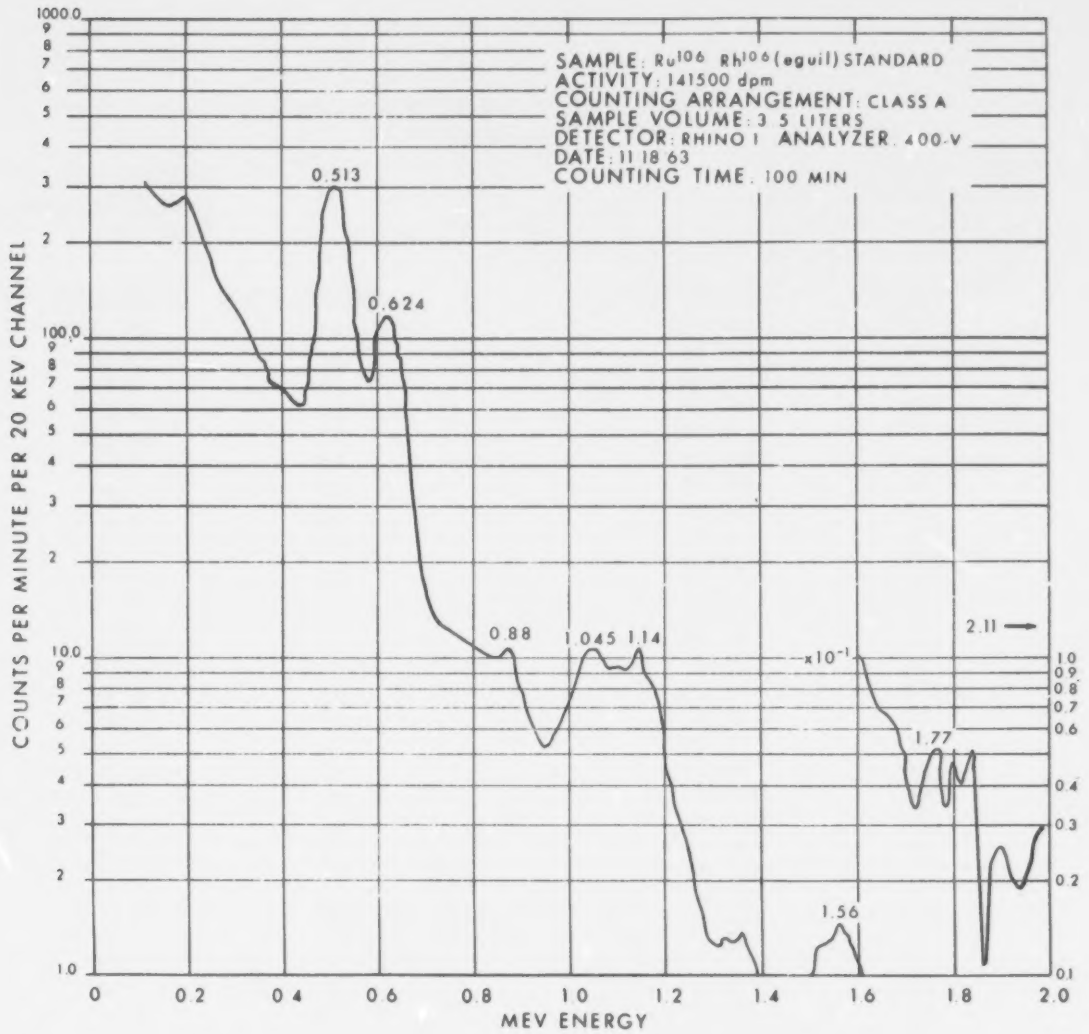
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{4745.29}{58500} = 0.0811$$

Ru^{106} - Rh^{106} (equil) STANDARD
11-18-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 141,500 dpm

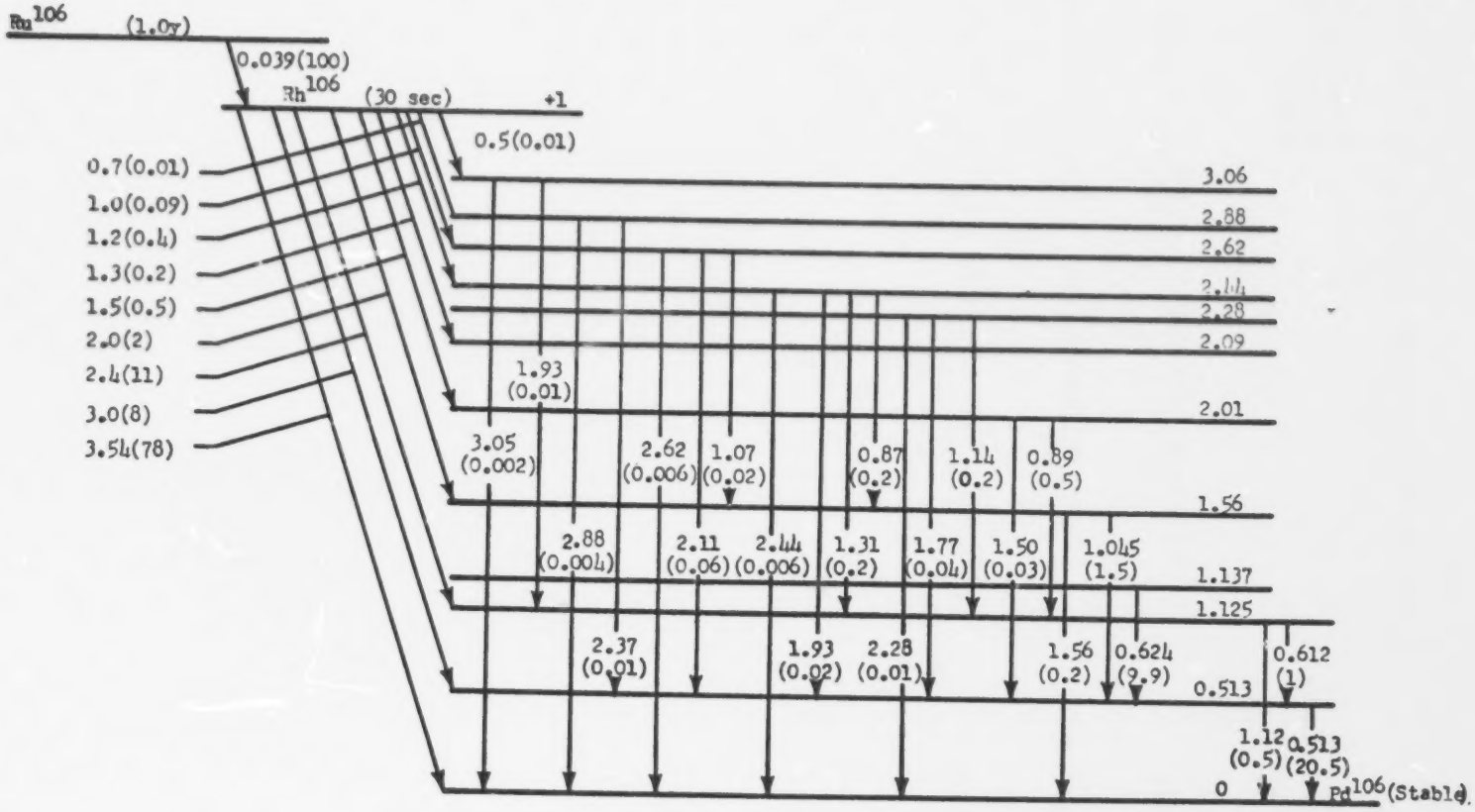
20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
06	304.29	53	10.48
07	281.75	54	9.35
08	264.64	55	9.41
09	274.60	56	9.22
10	279.46	57	10.51
11	235.68	58	9.12
12	190.66	59	7.80
13	159.10	60	5.21
14	140.10	61	3.70
15	124.26	62	2.68
16	110.50	63	2.05
17	95.42	64	1.45
18	81.22	65	1.26
19	73.48	66	1.28
20	70.63	67	1.29
21	63.61	68	1.38
22	62.78	69	1.09
23	86.71	70	0.95
24	175.51	71	0.88
25	288.89	72	0.84
26	292.74	73	0.86
27	182.21	74	0.88
28	89.87	75	0.99
29	72.95	76	1.26
30	102.21	77	1.29
31	118.34	78	1.46
32	96.45	79	1.34
33	54.37	80	1.15
34	28.56	81	0.91
35	17.61	82	0.71
36	13.80	83	0.66
37	12.42	84	0.62
38	12.22	85	0.50
39	11.47	86	0.34
40	11.12	87	0.45
41	10.76	88	0.51
42	10.29	89	0.34
43	10.63	90	0.46
44	10.08	91	0.40
45	8.30	92	0.51
46	6.48	93	0.11
47	5.42	94	0.27
48	5.57	95	0.31
49	6.37	96	0.22
50	7.41	97	0.19
51	9.55	98	0.24
52	10.43	99	0.29


SAMPLE: Ru106 Rh106 (equil) STANDARD
ACTIVITY: 141500 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER. 400-V
DATE: 11 18 63
COUNTING TIME. 100 MIN
0.513
0.624
0.88
1.045
1.14
2.11
x10⁻¹
1.77
1.56
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY

Ruthenium-106 - Rhodium-106 (equil) DECAY SCHEME

11/29/63



Ru^{106} - Rh^{106} (equil) EFFICIENCIES
11-18-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 141,500 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 26}}{\text{dpm}} = \frac{292.74}{141,500} = 0.00207$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 23-27}}{\text{dpm}} = \frac{1025.06}{141,500} = 0.00724$

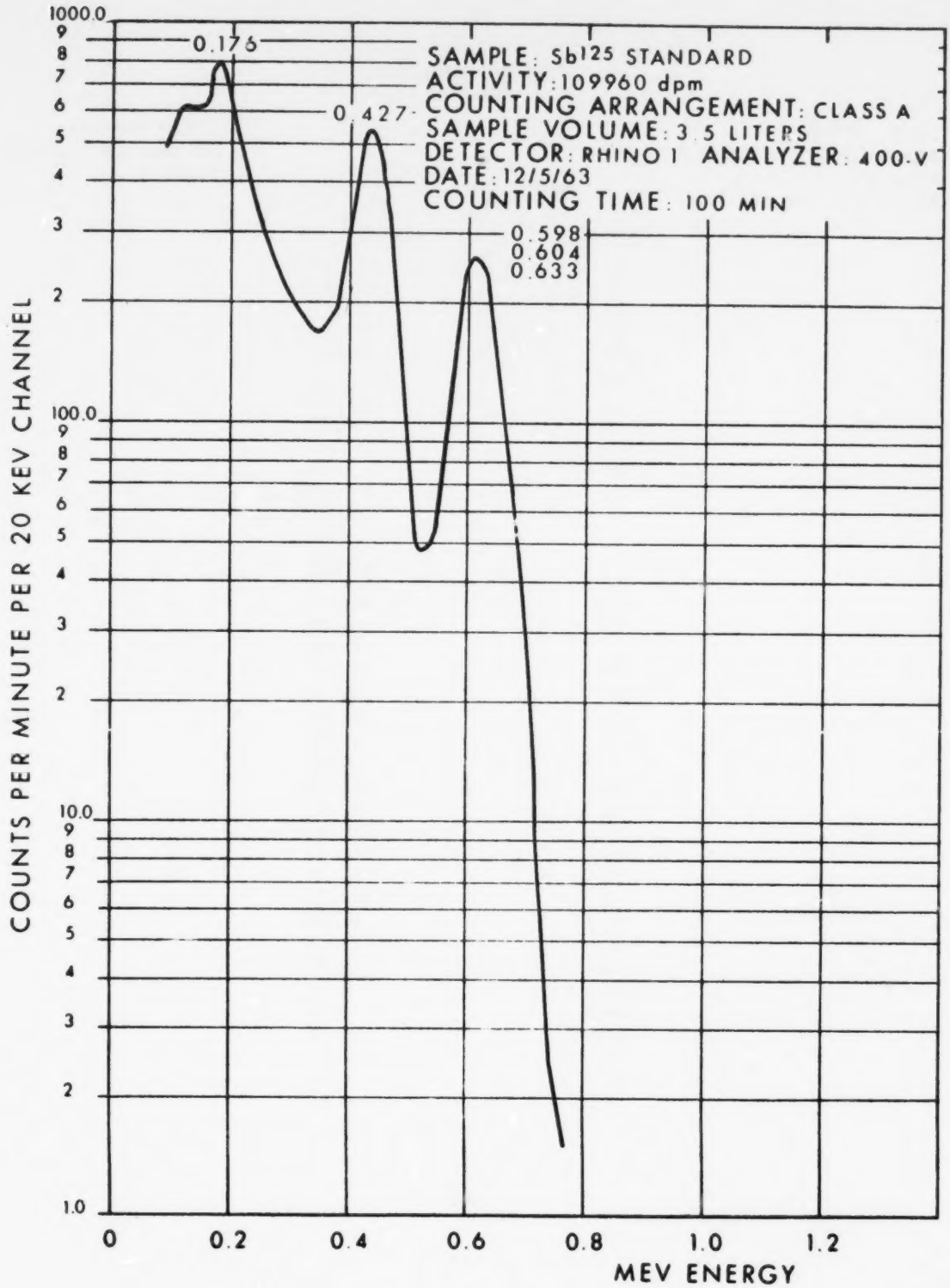
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{4687.74}{141,500} = 0.0303$

Sb^{125} STANDARD
12-5-63

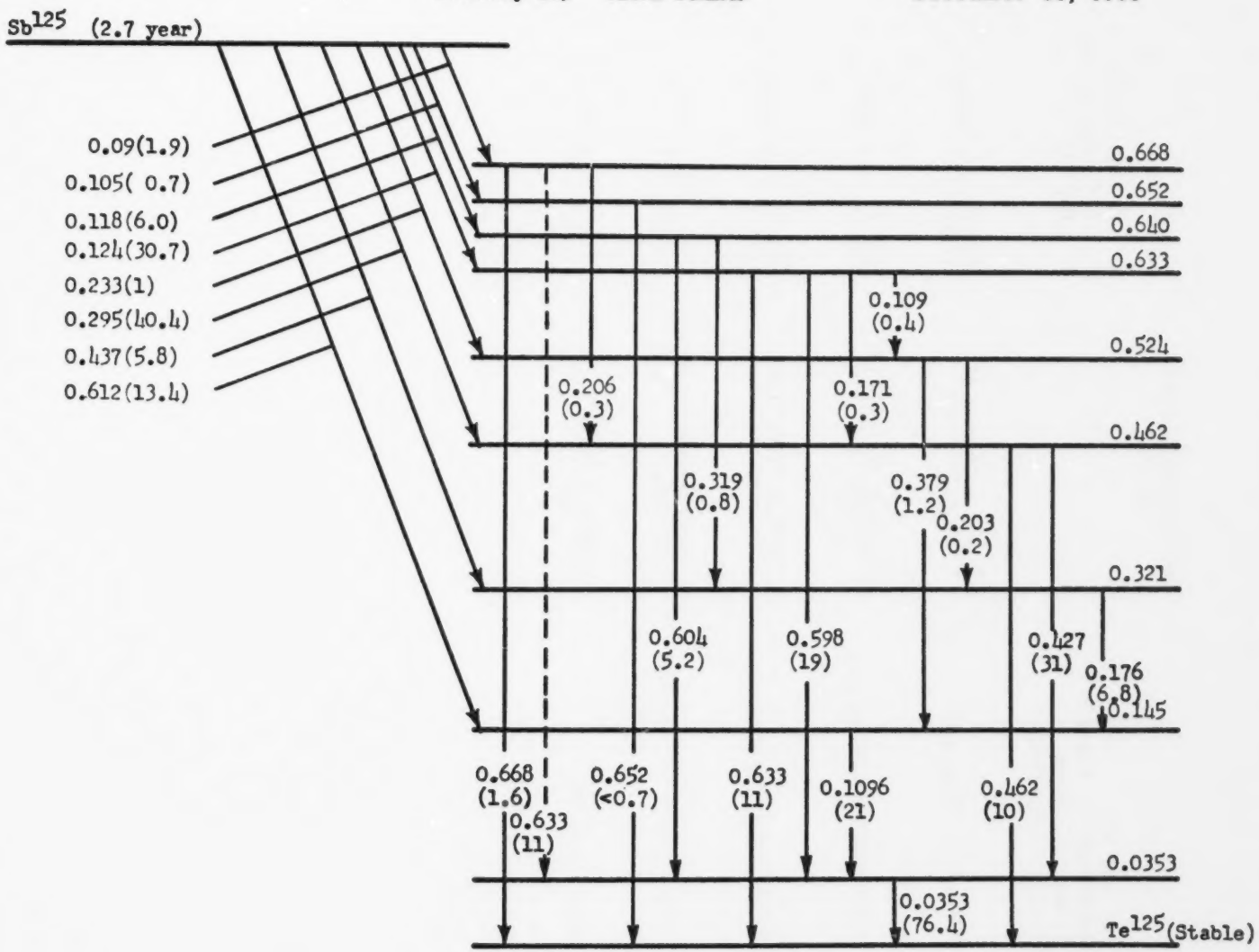
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 109,960 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
05	513.61
06	605.64
07	601.71
08	615.44
09	776.09
10	654.73
11	457.58
12	354.20
13	284.45
14	234.74
15	200.50
16	180.99
17	168.60
18	175.98
19	212.91
20	341.61
21	499.20
22	510.06
23	360.91
24	199.17
25	93.03
26	48.93
27	50.46
28	101.74
29	187.21
30	255.50
31	248.46
32	180.45
33	108.77
34	54.96
35	23.38
36	8.39
37	2.67
38	1.06
39	0.44
40	0.16
41	0.14
42	0.00


SAMPLE: Sb125 STANDARD
ACTIVITY: 109960 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3.5 LITERS
DETECTOR: RHINO 1 ANALYZER: 400-V
DATE: 12/5/63
COUNTING TIME: 100 MIN
0.176
0.427
0.598
0.604
0.633
COUNTS PER MINUTE PER 20 KEV CHANNEL
1000.0
100.0
10.0
1.0
0
0.2
0.4
0.6
0.8
1.0
1.2
MEV ENERGY

Antimony 125 DECAY SCHEME December 23, 1963



Sb^{125} EFFICIENCIES
12-5-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 109,960 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.}_{(0.427)} = \frac{\Sigma \text{ counts in Channel 22}}{\text{dpm}} = \frac{510.06}{109960} = 0.00464$$

$$\text{Total Photopeak Eff.}_{(0.427)} = \frac{\Sigma \text{ counts in Channels 19-24}}{\text{dpm}} = \frac{2123.86}{109960} = 0.0193$$

$$\text{Total Peak Eff.}_{(0.604)} = \frac{\Sigma \text{ counts in Channel 30}}{\text{dpm}} = \frac{255.50}{109960} = 0.00232$$

$$\text{Total Photopeak Eff.}_{(0.604)} = \frac{\Sigma \text{ counts in Channels 28-33}}{\text{dpm}} = \frac{1082.13}{109960} = 0.00984$$

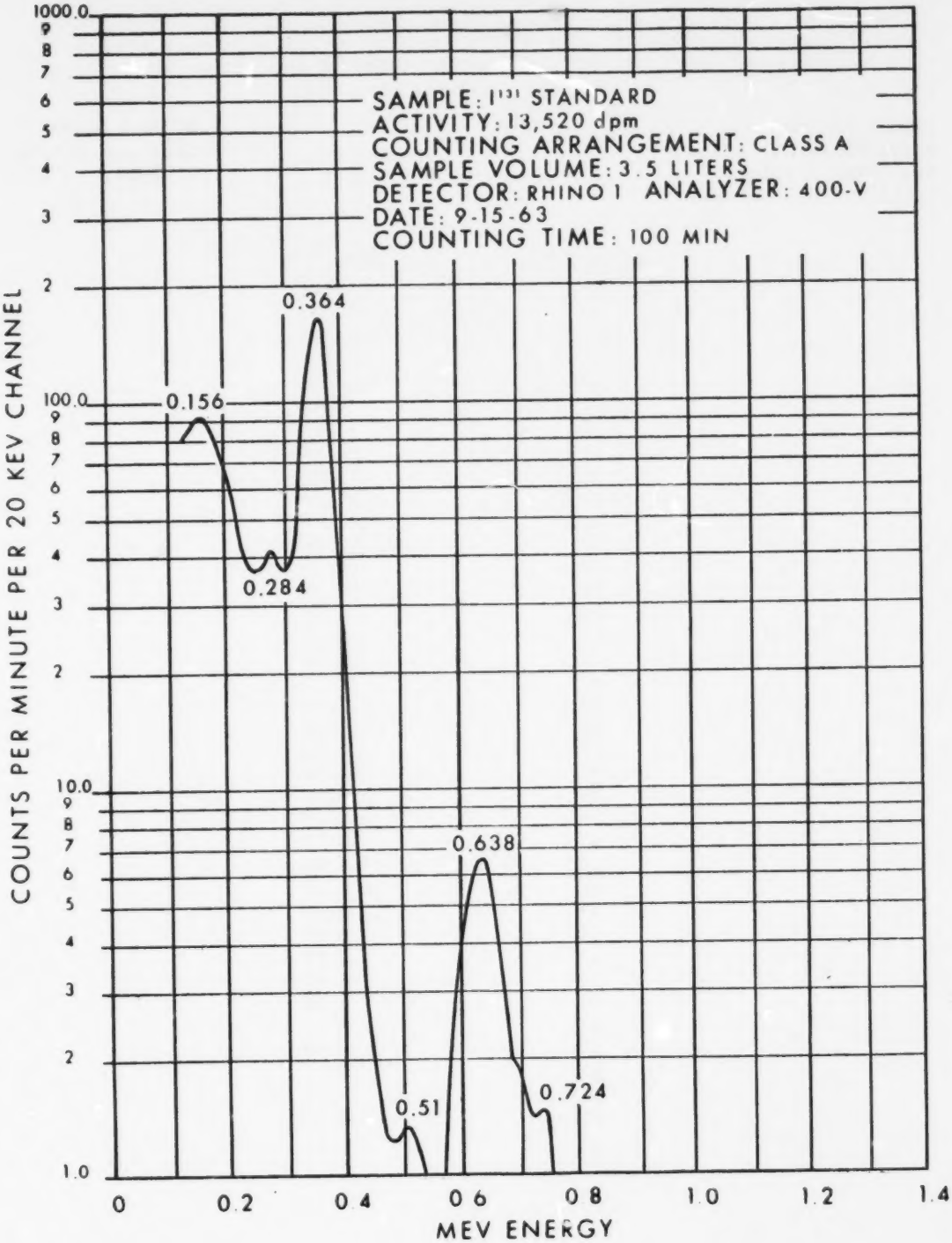
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{9313.87}{109960} = 0.0847$$

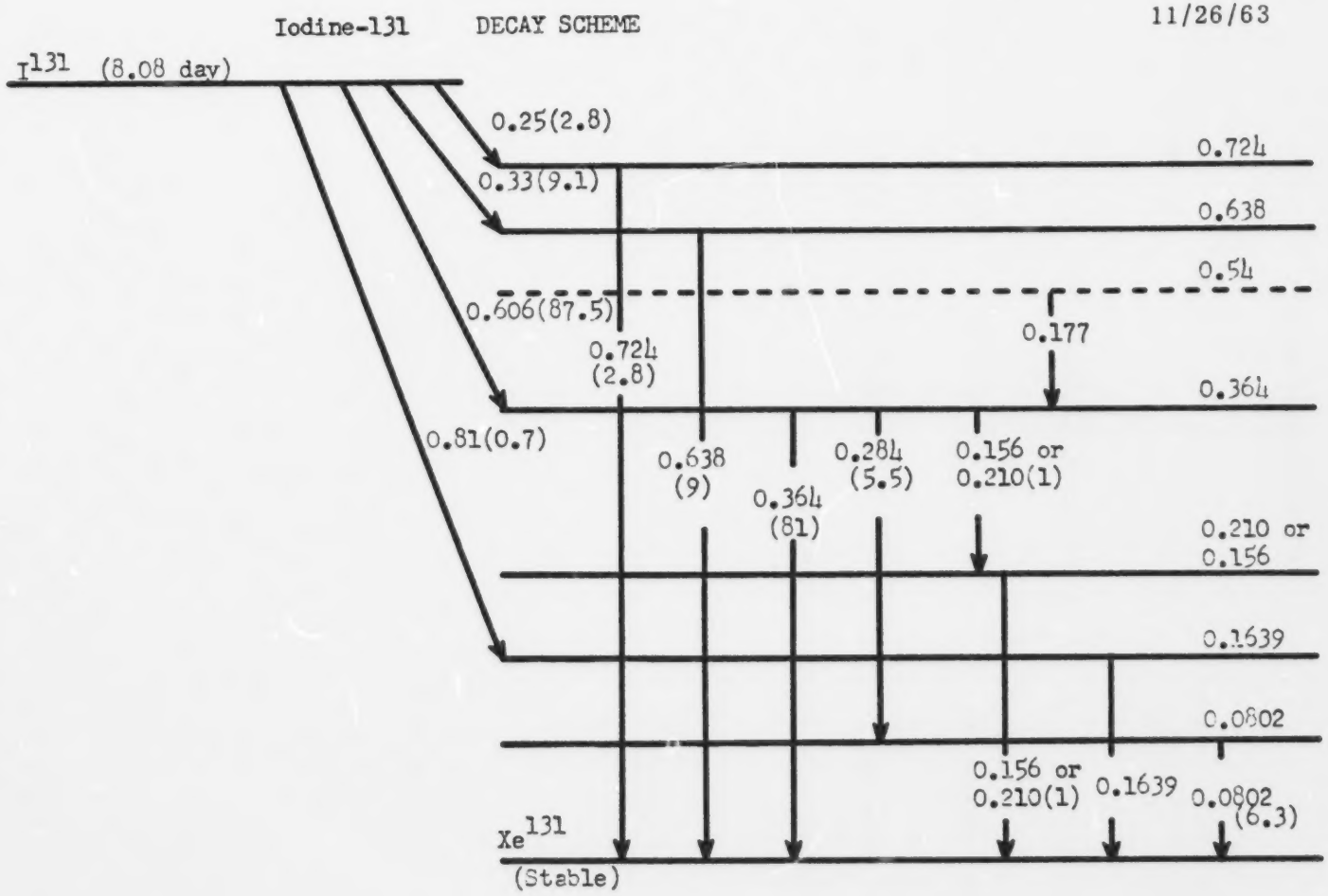
I^{131} STANDARD
9-15-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 13,520 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
06	79.40
07	82.50
08	91.86
09	84.63
10	63.23
11	47.47
12	37.21
13	37.40
14	42.87
15	36.28
16	43.83
17	106.66
18	161.13
19	104.52
20	31.14
21	6.45
22	2.71
23	1.59
24	1.23
25	1.34
26	1.23
27	0.71
28	0.90
29	1.87
30	3.87
31	5.89
32	6.38
33	4.25
34	2.05
35	1.87
36	1.40
37	1.49
38	0.51
39	0.28
40	0
41	0
42	0


SAMPLE: I¹³¹ STANDARD
ACTIVITY: 13,520 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3.5 LITERS
DETECTOR: RHINO 1 ANALYZER: 400-V
DATE: 9-15-63
COUNTING TIME: 100 MIN
0.156
0.284
0.364
0.51
0.638
0.724
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
1000.0
100.0
10.0
1.0
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4


Iodine-131 DECAY SCHEME
11/26/63
I131 (8.08 day)
0.25(2.8)
0.33(9.1)
0.606(87.5)
0.81(0.7)
0.724
0.638
0.54
0.177
0.364
0.724 (2.8)
0.638 (9)
0.364 (81)
0.284 (5.5)
0.156 or 0.210(1)
0.210 or 0.156
0.1639
0.0802
0.156 or 0.210(1)
0.1639
0.0802 (6.3)
Xe131 (Stable)

I^{131} EFFICIENCIES
9-15-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 13,520 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 18}}{\text{dpm}} = \frac{161.13}{13520} = 0.0119$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 16-20}}{\text{dpm}} = \frac{447.28}{13520} = 0.0331$

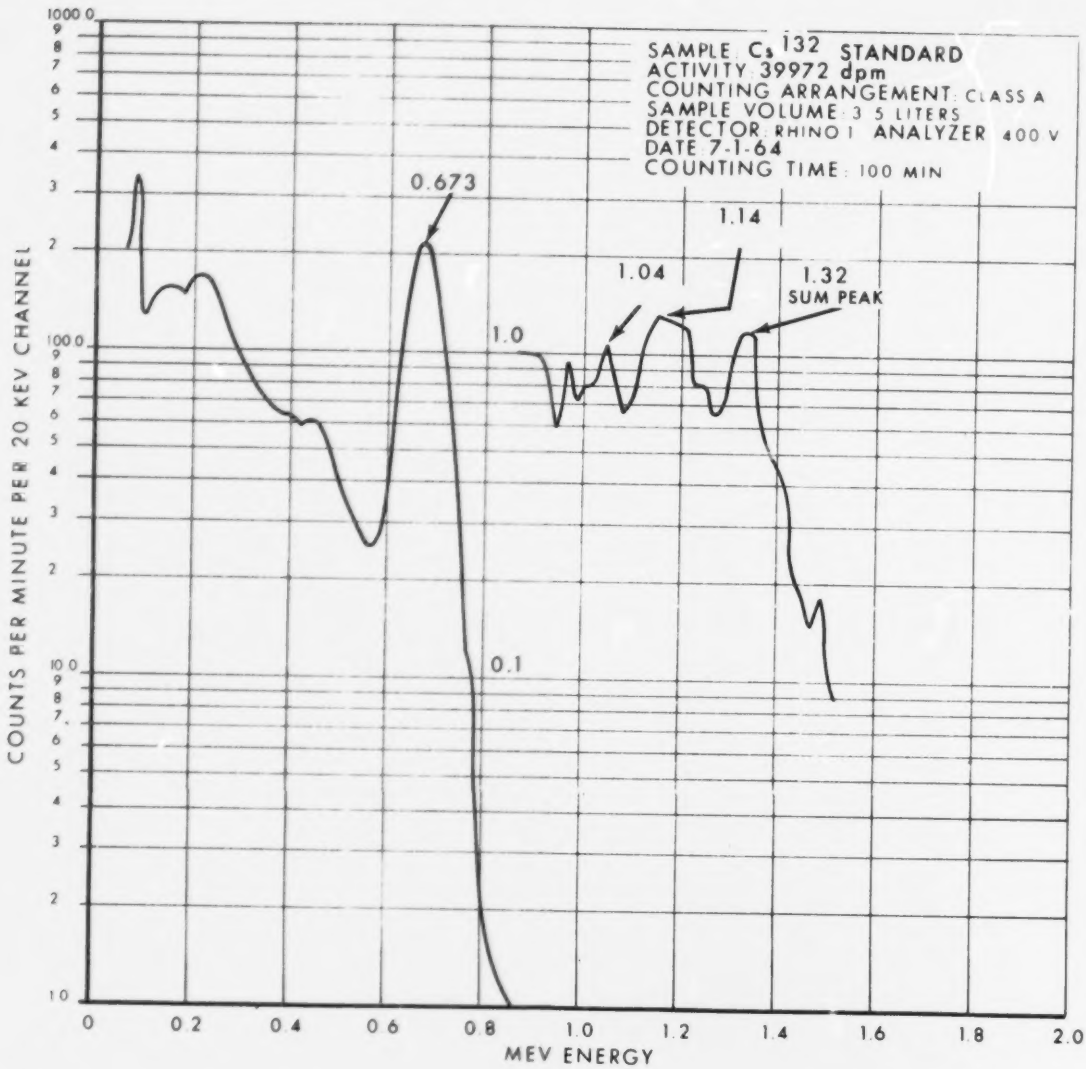
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{1096.15}{13520} = 0.0811$

Cs^{132} STANDARD
7/1/64

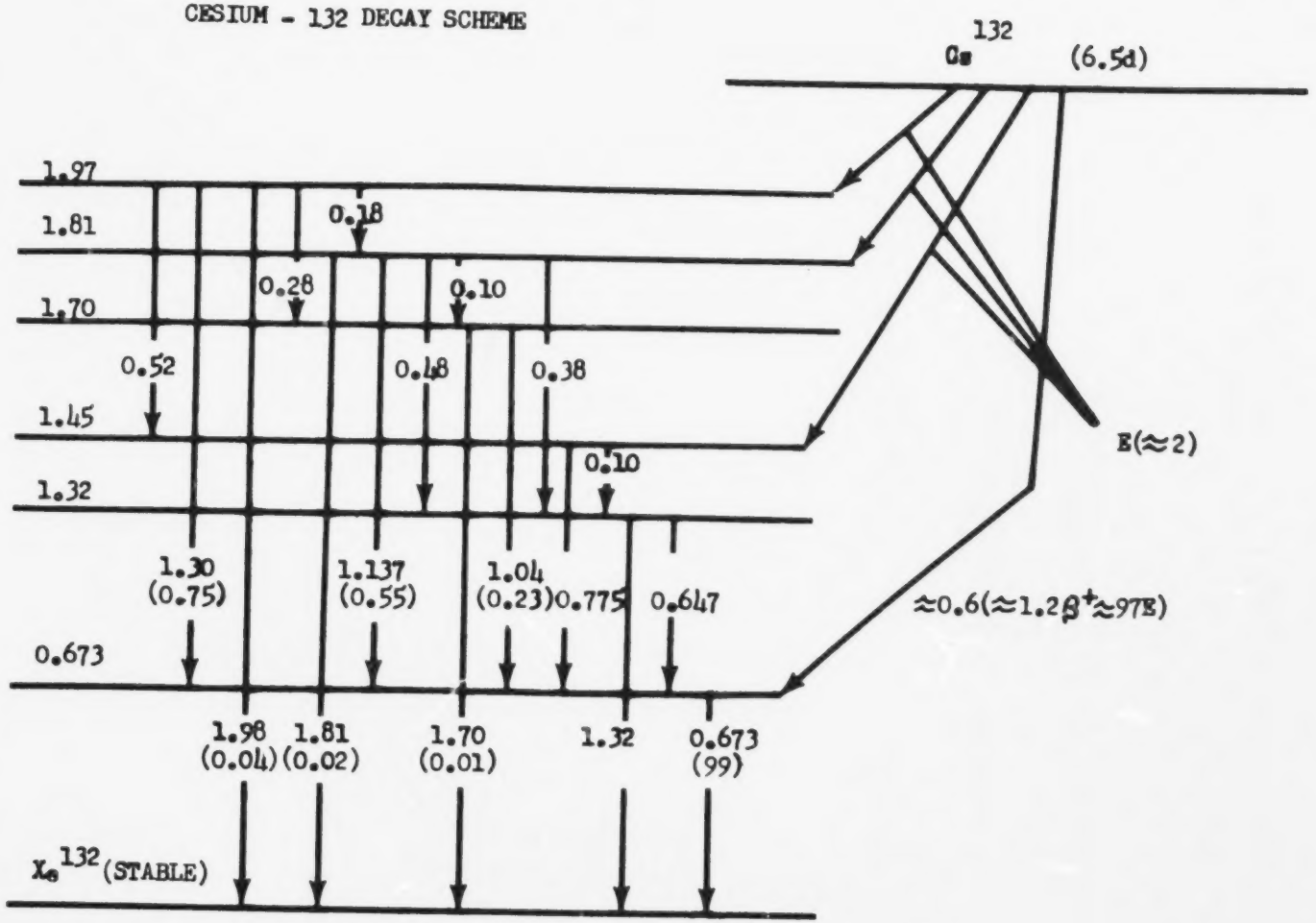
TIME: 100 Min.
ARRANGEMENT: Class A
VOLUME: 3.5 Liters
ACTIVITY: 39972 dpm

20 Kev/ channel
Net counts per minute
RHINO I

Channel No.	Counts
03	202.36
04	335.51
05	127.08
06	144.68
07	153.20
08	152.48
09	149.01
10	164.03
11	166.04
12	143.71
13	120.34
14	101.65
15	86.98
16	81.05
17	72.12
18	68.09
19	63.97
20	63.30
21	59.49
22	61.89
23	56.28
24	48.35
25	39.14
26	34.72
27	27.81
28	25.69
29	26.22
30	40.81
31	86.64
32	152.18
33	207.25
34	201.02
35	138.99
36	72.88
37	30.81
38	12.25
39	4.80
40	2.27
41	1.47
42	1.79
43	1.00
44	1.00
45	1.00
46	0.87
47	0.61
48	0.93
49	0.73
50	0.80
51	0.80
52	1.05
53	0.86
54	0.67
55	0.75
56	1.11
57	1.30
58	1.29
59	1.24
60	1.22
61	0.80
62	0.81
63	0.66
64	0.70
65	1.02
66	1.15
67	1.12
68	0.59
69	0.49
70	0.43
71	0.22
72	0.18
73	0.15
74	0.18
75	0.11
76	0.00
77	0.00
78	0.00
79	0.00
80	0.00


SAMPLE: Cs^{132} STANDARD
ACTIVITY: 39972 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER 400 V
DATE: 7-1-64
COUNTING TIME: 100 MIN
0.673
1.14
1.04
1.32
SUM PEAK
1.0
0.1
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0

CESIUM - 132 DECAY SCHEME



Cs^{132} EFFICIENCIES
7/1/64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 Liters
ACTIVITY: 39972 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in channel 33}}{\text{dpm}} = \frac{207.25}{39972} = 0.00518$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in channels 30-37}}{\text{dpm}} = \frac{930.58}{39972} = 0.0233$$

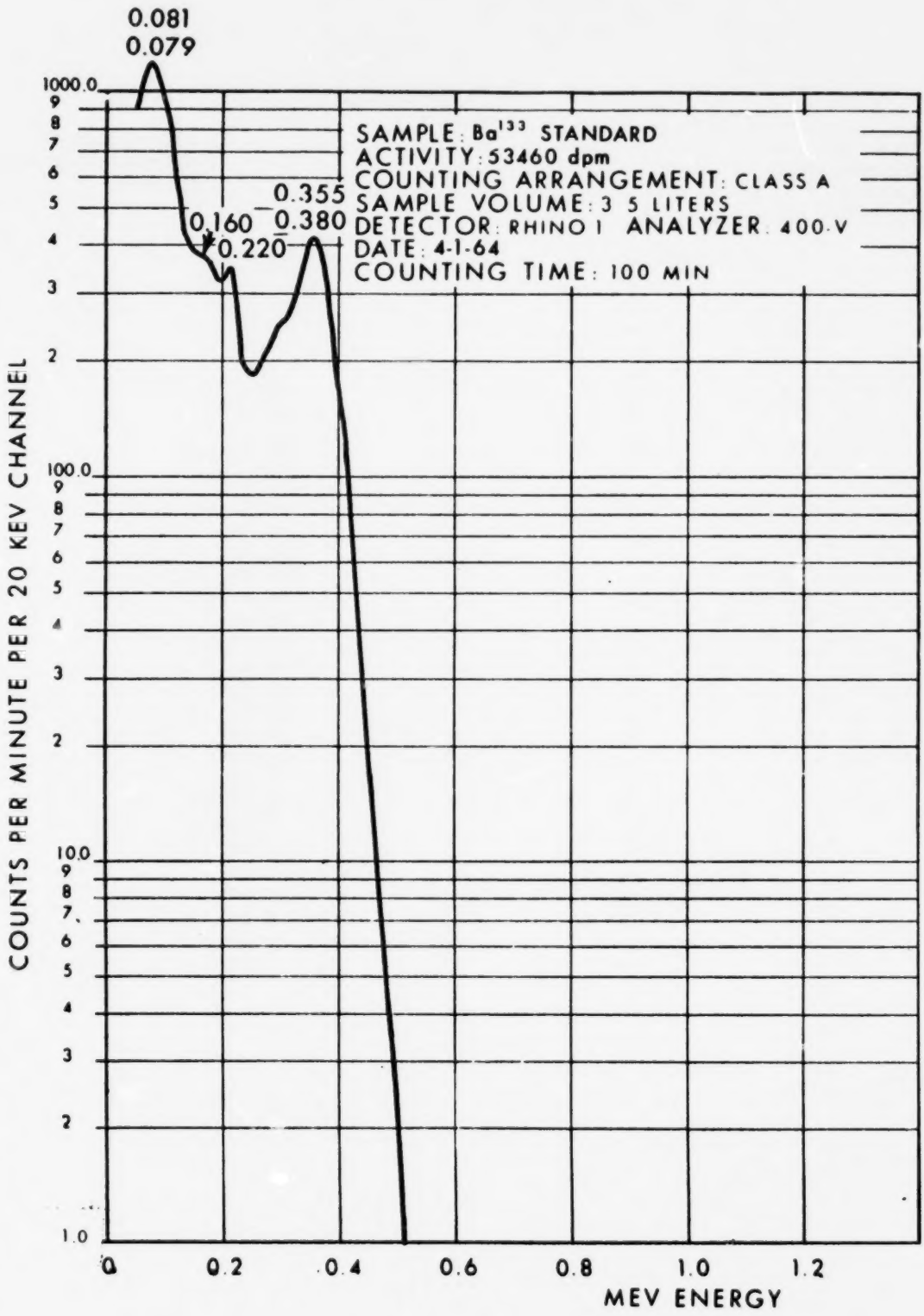
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in channels 3-99}}{\text{dpm}} = \frac{3753.59}{39972} = 0.0939$$

Ba^{133} STANDARD
4-1-64

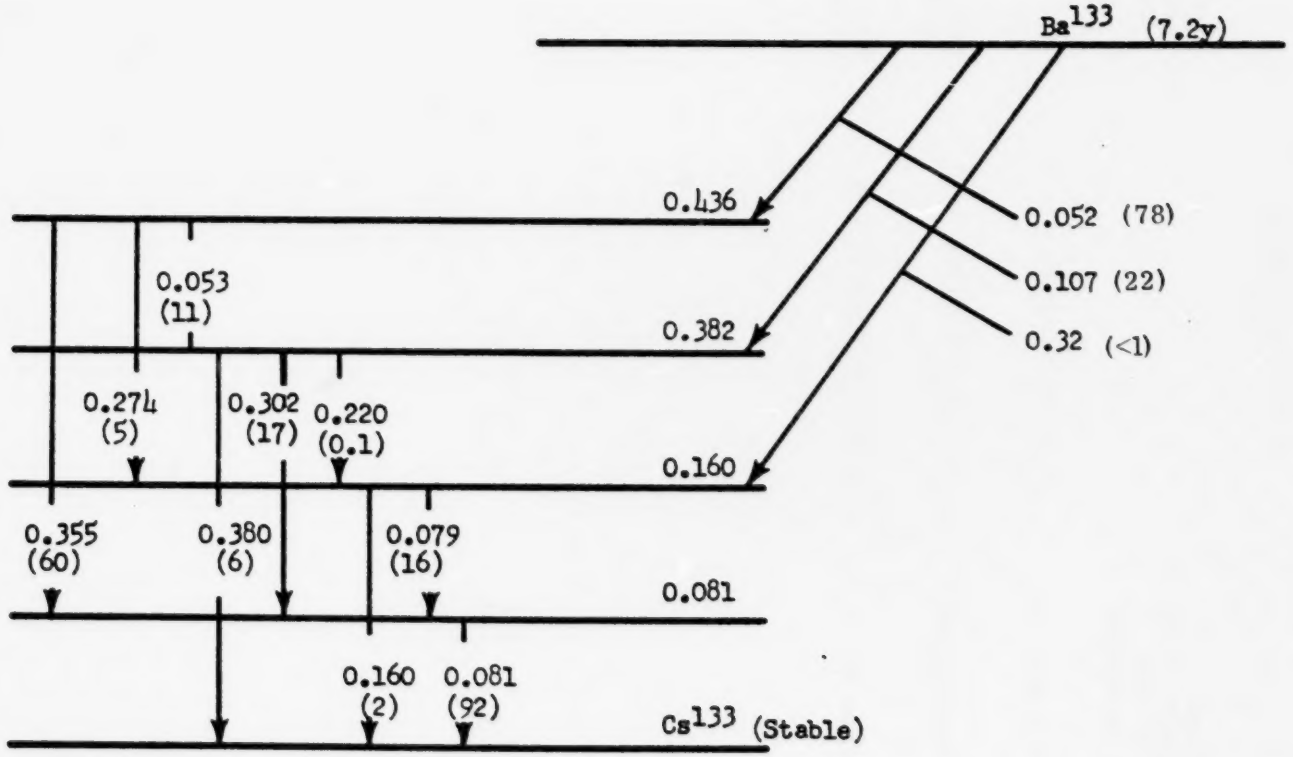
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liter
ACTIVITY: 53,460 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
03	907.73
04	1154.29
05	1029.90
06	751.07
07	422.15
08	379.74
09	370.50
10	322.35
11	346.91
12	197.85
13	182.34
14	210.29
15	249.27
16	266.91
17	329.06
18	413.09
19	342.68
20	193.25
21	77.16
22	34.85
23	16.59
24	7.12
25	2.72
26	0.80
27	0.60
28	0.25
29	0.07
30	0.00
31	0.00
32	0.00


0.081
0.079
0.160
0.220
0.355
0.380
SAMPLE: Ba133 STANDARD
ACTIVITY: 53460 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 4-1-64
COUNTING TIME: 100 MIN
COUNTS PER MINUTE PER 20 KEV CHANNEL
1000.0
100.0
10.0
1.0
0
0.2
0.4
0.6
0.8
1.0
1.2
MEV ENERGY

Barium-133 DECAY SCHEME 4/30/64



Ba^{133} EFFICIENCIES
4-1-64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liter
ACTIVITY: 53,460 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in Channel 18}}{\text{dpm}} = \frac{413.09}{53460} = 0.00773$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in Channels 16-20}}{\text{dpm}} = \frac{1544.99}{53460} = 0.0289$$

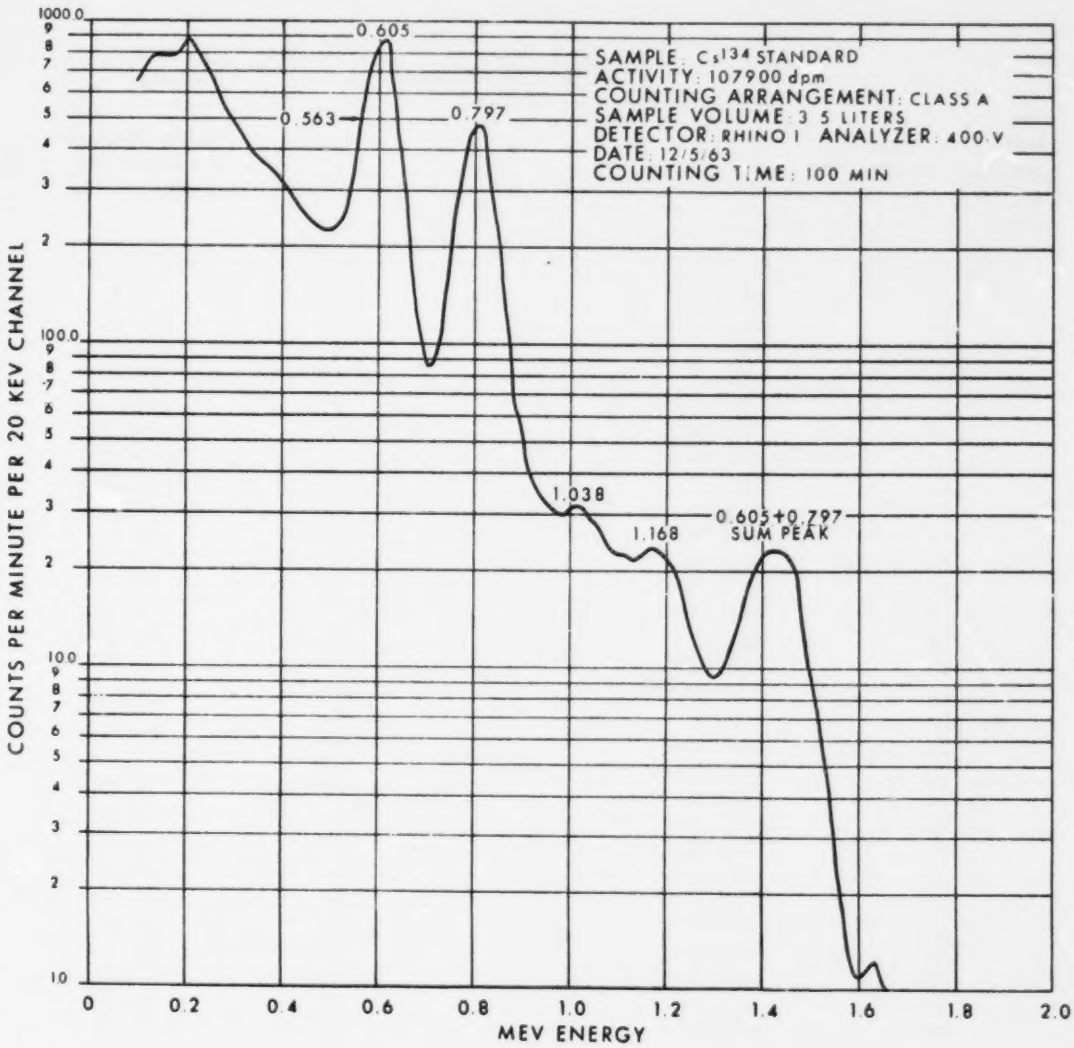
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 3-99}}{\text{dpm}} = \frac{8209.54}{53460} = 0.154$$

Cs^{134} STANDARD
12-5-63

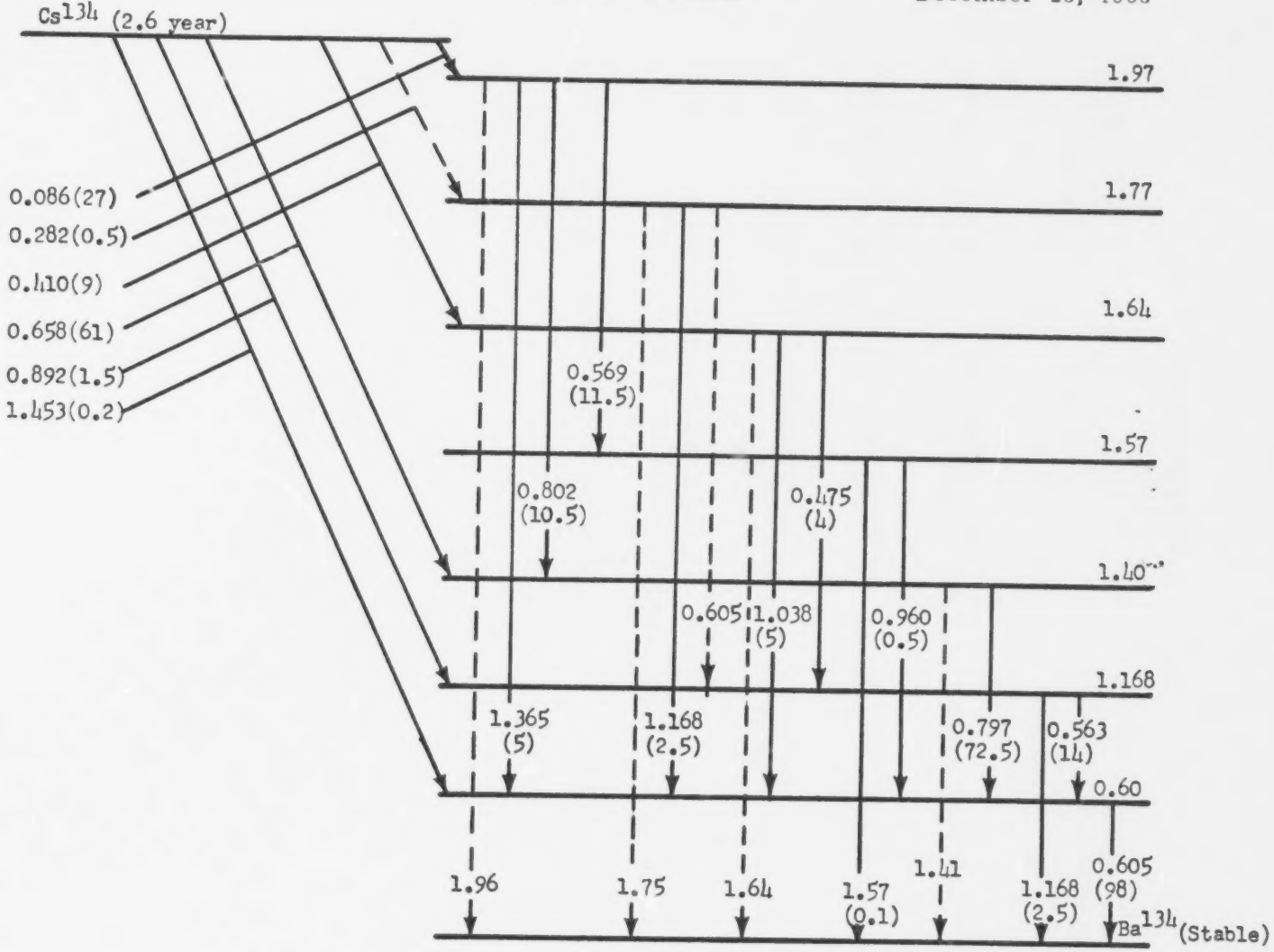
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 107,900 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
05	657.49	45	44.37
06	748.12	46	37.47
07	791.18	47	33.45
08	780.94	48	32.92
09	782.83	49	30.89
10	882.26	50	32.60
11	846.93	51	31.28
12	728.57	52	29.01
13	611.58	53	26.26
14	523.79	54	23.81
15	462.29	55	23.24
16	417.01	56	22.34
17	386.36	57	23.51
18	369.55	58	24.29
19	345.02	59	23.09
20	317.90	60	21.60
21	281.99	61	17.27
22	259.23	62	13.29
23	239.64	63	11.28
24	230.92	64	9.79
25	228.79	65	9.25
26	248.23	66	11.69
27	335.47	67	14.53
28	514.37	68	18.19
29	741.29	69	22.27
30	861.49	70	23.82
31	705.74	71	23.67
32	418.64	72	22.70
33	208.47	73	17.02
34	113.70	74	11.96
35	85.45	75	7.19
36	100.65	76	4.74
37	170.16	77	2.62
38	311.58	78	1.68
39	437.25	79	1.16
40	476.36	80	1.20
41	370.15	81	1.29
42	229.50	82	1.09
43	123.80	83	1.03
44	64.55	84	0.82


SAMPLE: Cs137 STANDARD
ACTIVITY: 107900 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 12/5/63
COUNTING TIME: 100 MIN
0.605
0.563
0.797
1.038
1.168
0.605+0.797
SUM PEAK
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0

Cesium - 134 DECAY SCHEME December 23, 1963



Cs^{134} EFFICIENCIES
12-5-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 107,900 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.}_{(0.605)} = \frac{\Sigma \text{ counts in Channel 30}}{\text{dpm}} = \frac{861.49}{107900} = 0.00798$$

$$\text{Total Photopeak Eff.}_{(0.605)} = \frac{\Sigma \text{ counts in Channels 27-32}}{\text{dpm}} = \frac{3577.00}{107900} = 0.0332$$

$$\text{Total Peak Eff.}_{(0797)} = \frac{\Sigma \text{ counts in Channel 40}}{\text{dpm}} = \frac{476.36}{107900} = 0.00441$$

$$\text{Total Photopeak Eff.}_{(0.797)} = \frac{\Sigma \text{ counts in Channels 38-42}}{\text{dpm}} = \frac{1824.84}{107900} = 0.0169$$

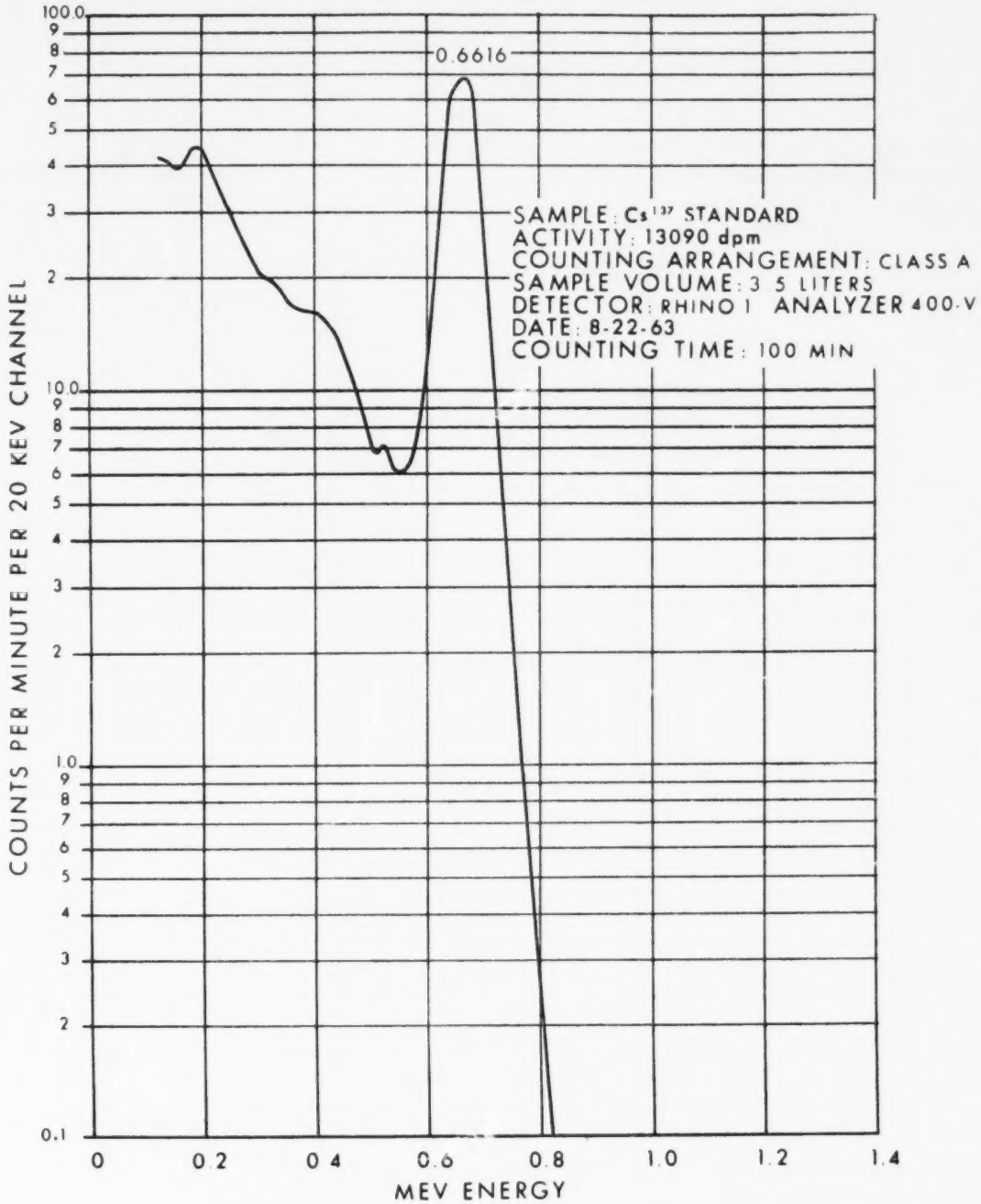
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{18117.92}{107900} = 0.168$$

Cs^{137} STANDARD
8-22-63

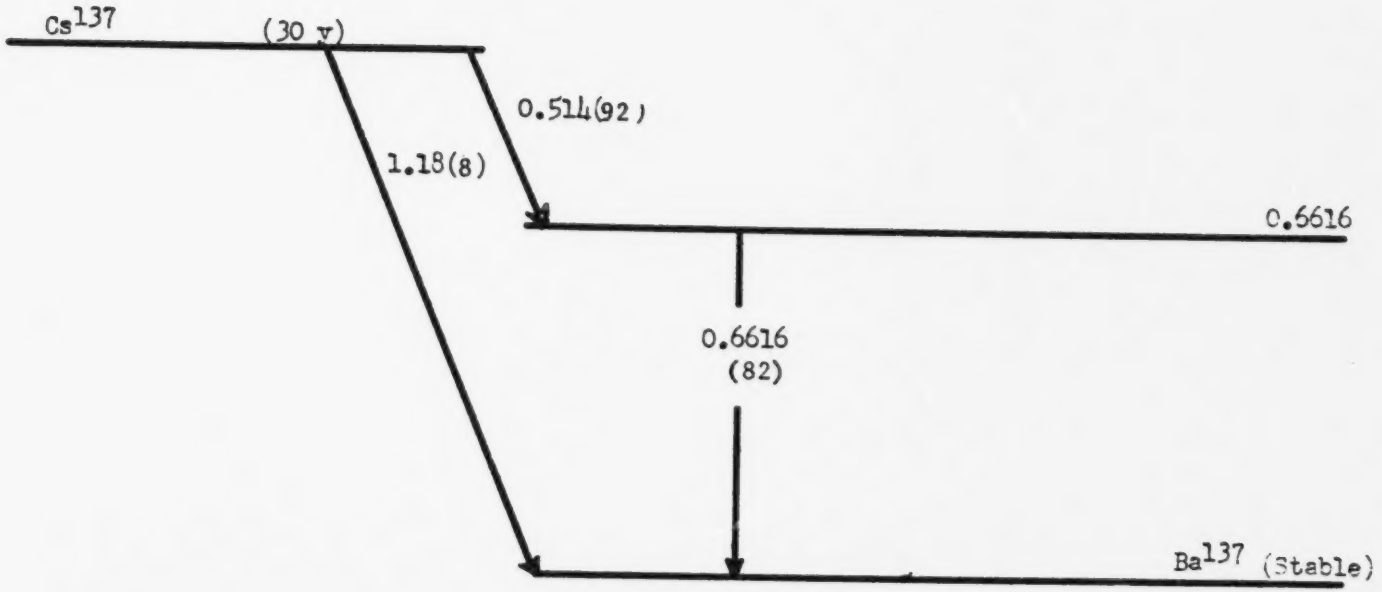
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 13090 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
06	40.77
07	40.08
08	38.05
09	44.08
10	43.79
11	36.51
12	31.49
13	26.26
14	23.84
15	20.83
16	19.99
17	18.92
18	16.69
19	16.66
20	16.50
21	15.62
22	13.86
23	11.69
24	9.04
25	6.88
26	7.11
27	6.03
28	6.14
29	7.47
30	14.56
31	34.35
32	63.05
33	67.05
34	50.14
35	23.51
36	8.32
37	2.84
38	1.09
39	0.41
40	0.17
41	0.10


0.6616
SAMPLE: Cs137 STANDARD
ACTIVITY: 13090 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO 1 ANALYZER 400-V
DATE: 8-22-63
COUNTING TIME: 100 MIN
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
100.0
10.0
1.0
0.1
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

Cesium-137 DECAY SCHEME 4/30/64



Cs^{137} EFFICIENCIES
8-22-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 13090 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 33}}{\text{dpm}} = \frac{67.05}{13090} = 0.00512$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 30-36}}{\text{dpm}} = \frac{260.98}{13090} = 0.0199$

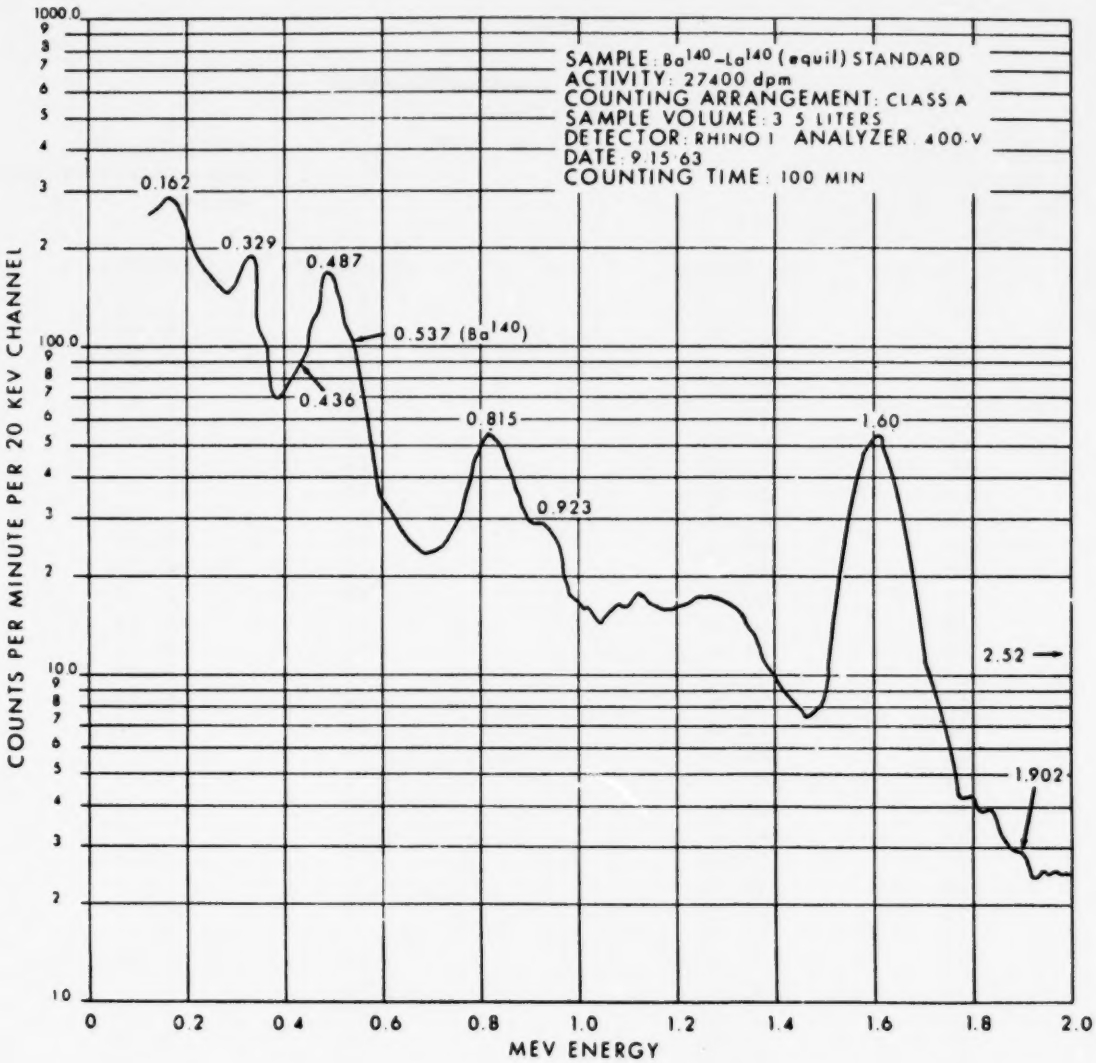
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{783.89}{13090} = 0.0599$

Ba^{140} - La^{140} (equil) STANDARD
9-15-63

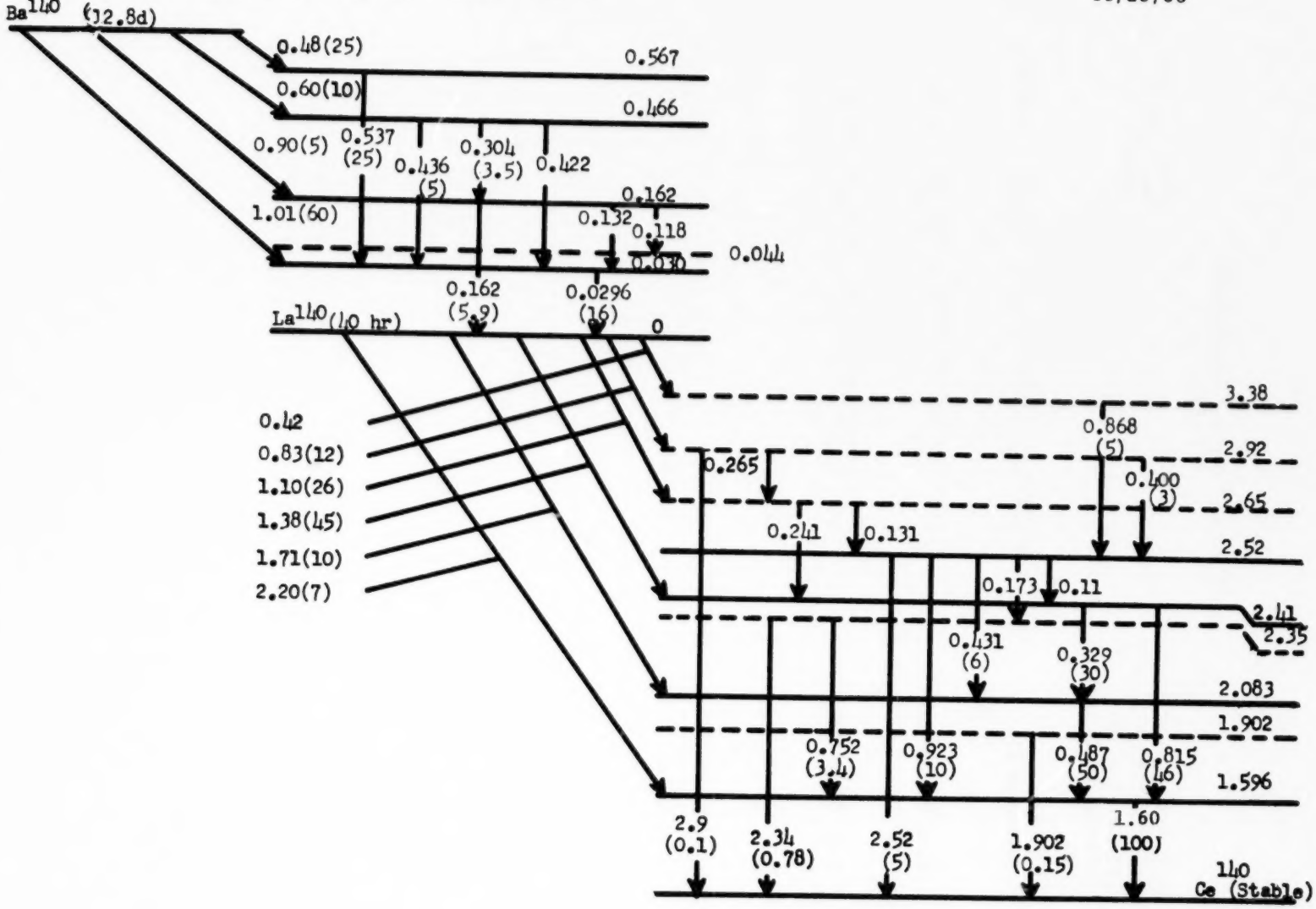
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 27400 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
06	258.25	53	15.24
07	262.59	54	16.73
08	285.11	55	16.26
09	269.98	56	17.98
10	223.05	57	17.06
11	199.54	58	16.31
12	178.82	59	16.27
13	159.98	60	16.35
14	147.34	61	16.23
15	157.34	62	17.34
16	183.76	63	17.35
17	158.34	64	17.12
18	99.62	65	16.83
19	72.45	66	16.35
20	72.30	67	14.93
21	80.86	68	13.23
22	92.04	69	11.23
23	121.63	70	9.97
24	162.54	71	8.75
25	161.81	72	8.22
26	132.52	73	7.48
27	105.24	74	7.86
28	75.17	75	9.24
29	49.68	76	15.01
30	35.77	77	22.71
31	29.78	78	35.41
32	27.11	79	45.47
33	25.08	80	52.16
34	23.59	81	50.74
35	24.03	82	41.45
36	24.54	83	29.36
37	27.33	84	19.50
38	32.45	85	12.12
39	40.31	86	9.39
40	49.83	87	7.02
41	53.76	88	5.50
42	48.81	89	4.33
43	41.35	90	4.24
44	33.43	91	3.73
45	29.64	92	3.92
46	29.77	93	3.33
47	27.14	94	2.98
48	22.91	95	2.95
49	18.02	96	2.51
50	16.45	97	2.58
51	16.37	98	2.55
52	14.41	99	2.77


SAMPLE: Ba^{140}–La^{140} (equil) STANDARD
ACTIVITY: 27400 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER 400-V
DATE: 9 15 63
COUNTING TIME: 100 MIN
0.162
0.329
0.487
0.537 (Ba^{140})
0.436
0.815
0.923
1.60
2.52
1.902
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0

Barium-140 - Lanthanum-140 (equil) DECAY SCHEMES 11/26/63



Ba^{140} - La^{140} (equil) EFFICIENCIES
9-15-63

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 27400 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in Channel 24}}{\text{dpm}} = \frac{162.54}{27,400} = 0.00592$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in Channels 22-28}}{\text{dpm}} = \frac{850.95}{27,400} = 0.0311$$

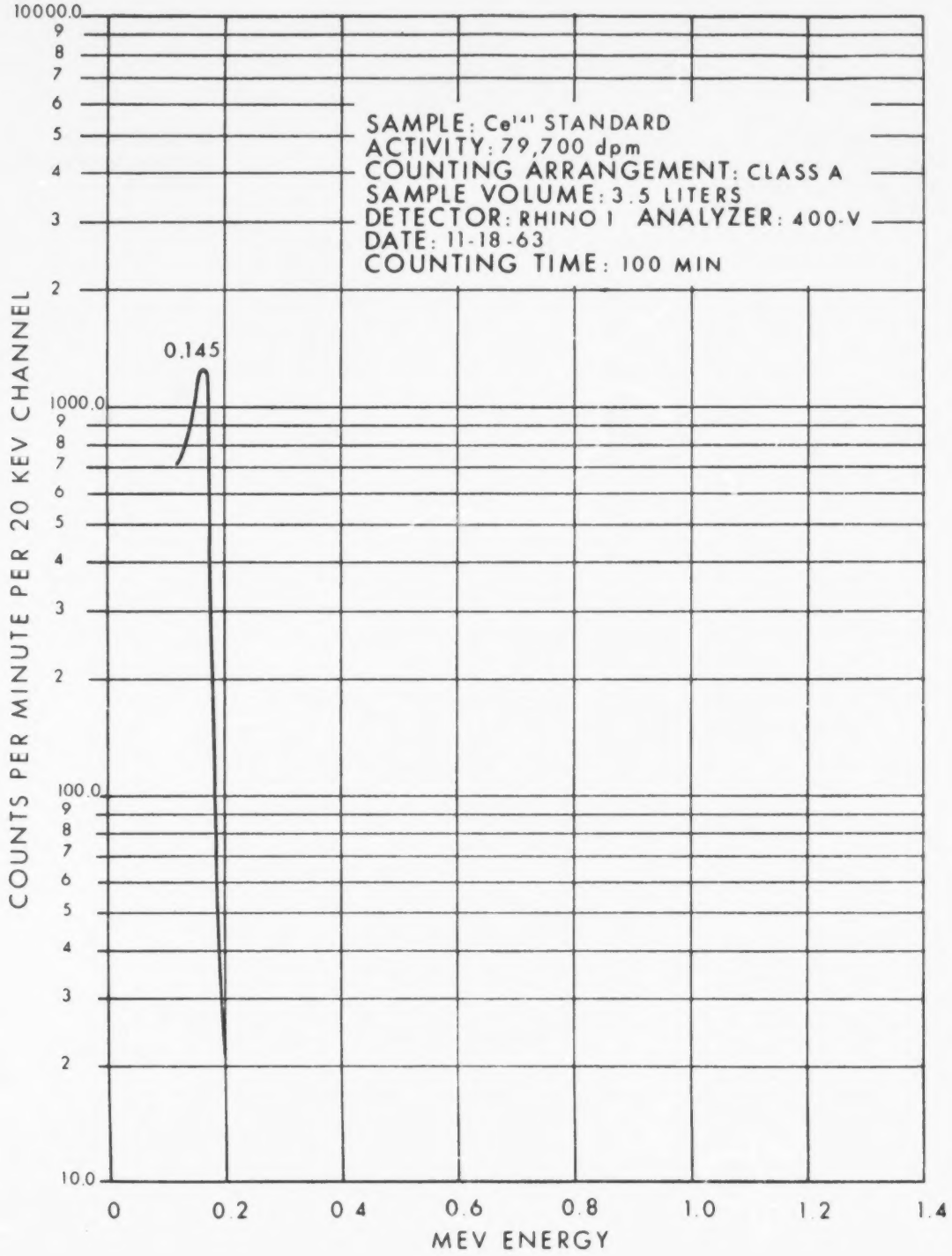
$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{5107.90}{27,400} = 0.186$$

Ce^{141} STANDARD
11-18-63

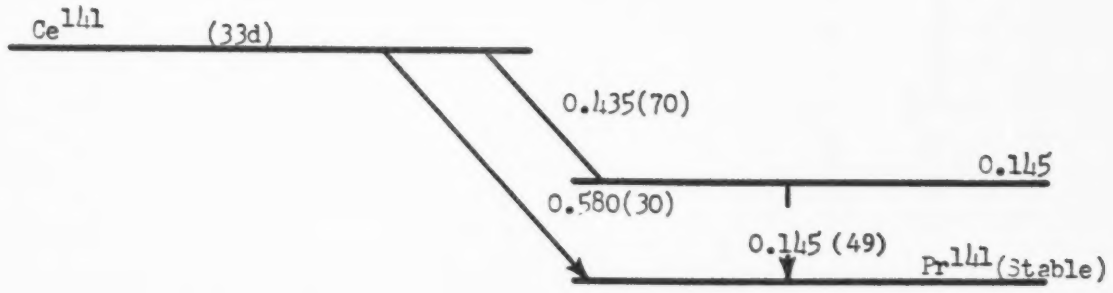
TIME: 10 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 79,700 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
06	719.82
07	935.21
08	1216.30
09	280.79
10	22.46
11	4.12
12	2.00
13	0.51
14	2.08
15	1.45
16	0.61
17	0.67
18	0
19	0
20	0


SAMPLE: Ce¹⁴¹ STANDARD
ACTIVITY: 79,700 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3.5 LITERS
DETECTOR: RHINO I ANALYZER: 400-V
DATE: 11-18-63
COUNTING TIME: 100 MIN
0.145
COUNTS PER MINUTE PER 20 KEV CHANNEL
10000.0
1000.0
100.0
10.0
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
MEV ENERGY

Cerium 141 DECAY SCHEME 11/29/63



Ce^{141} EFFICIENCIES
11-18-63

TIME: 10 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 79,700 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 8}}{\text{dpm}} = \frac{1216.30}{79700} = 0.0153$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 6-9}}{\text{dpm}} = \frac{3152.12}{79700} = 0.0395$

Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{3186.02}{79700} = 0.0400$

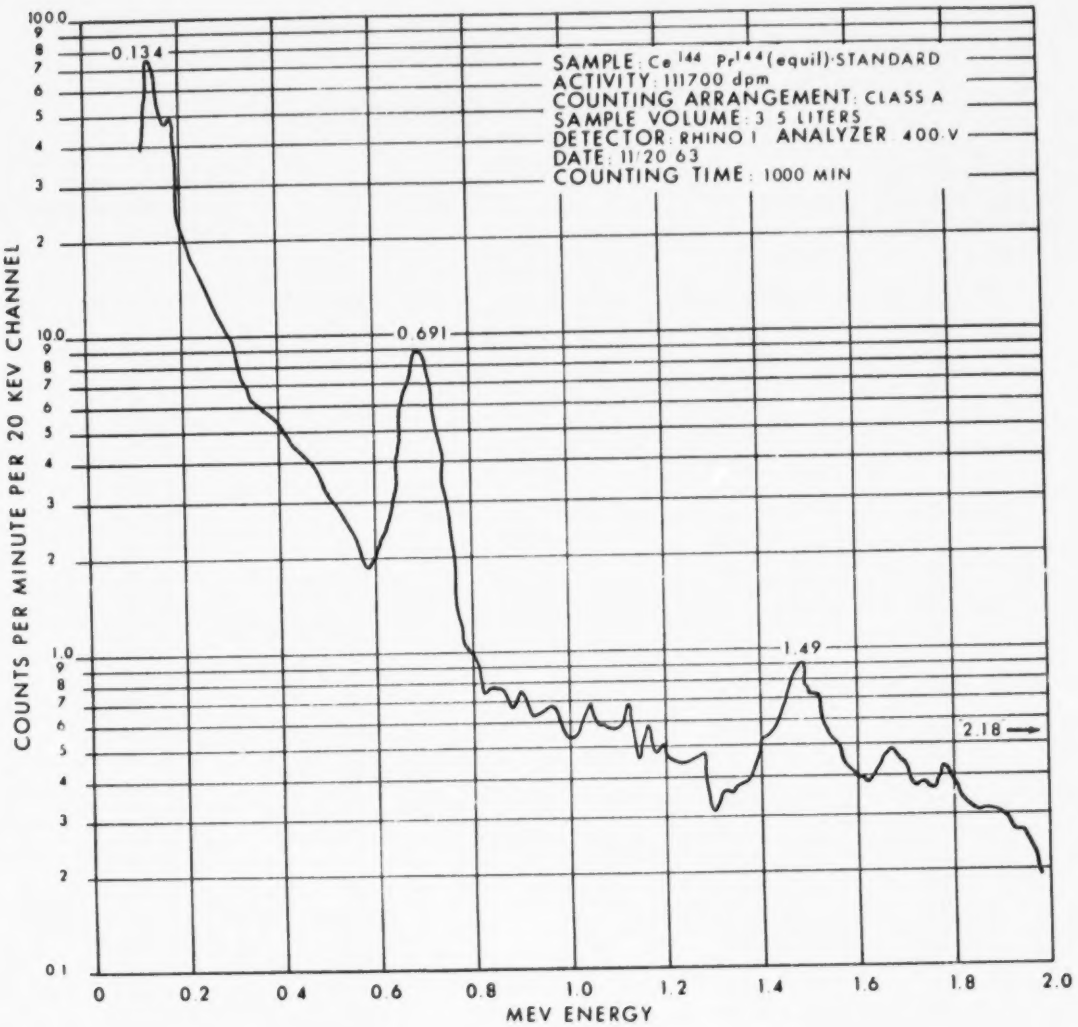
CERIUM-PRASEODYMIUM-144

Ce^{144} - Pr^{144} (equil) STANDARD
11-20-63

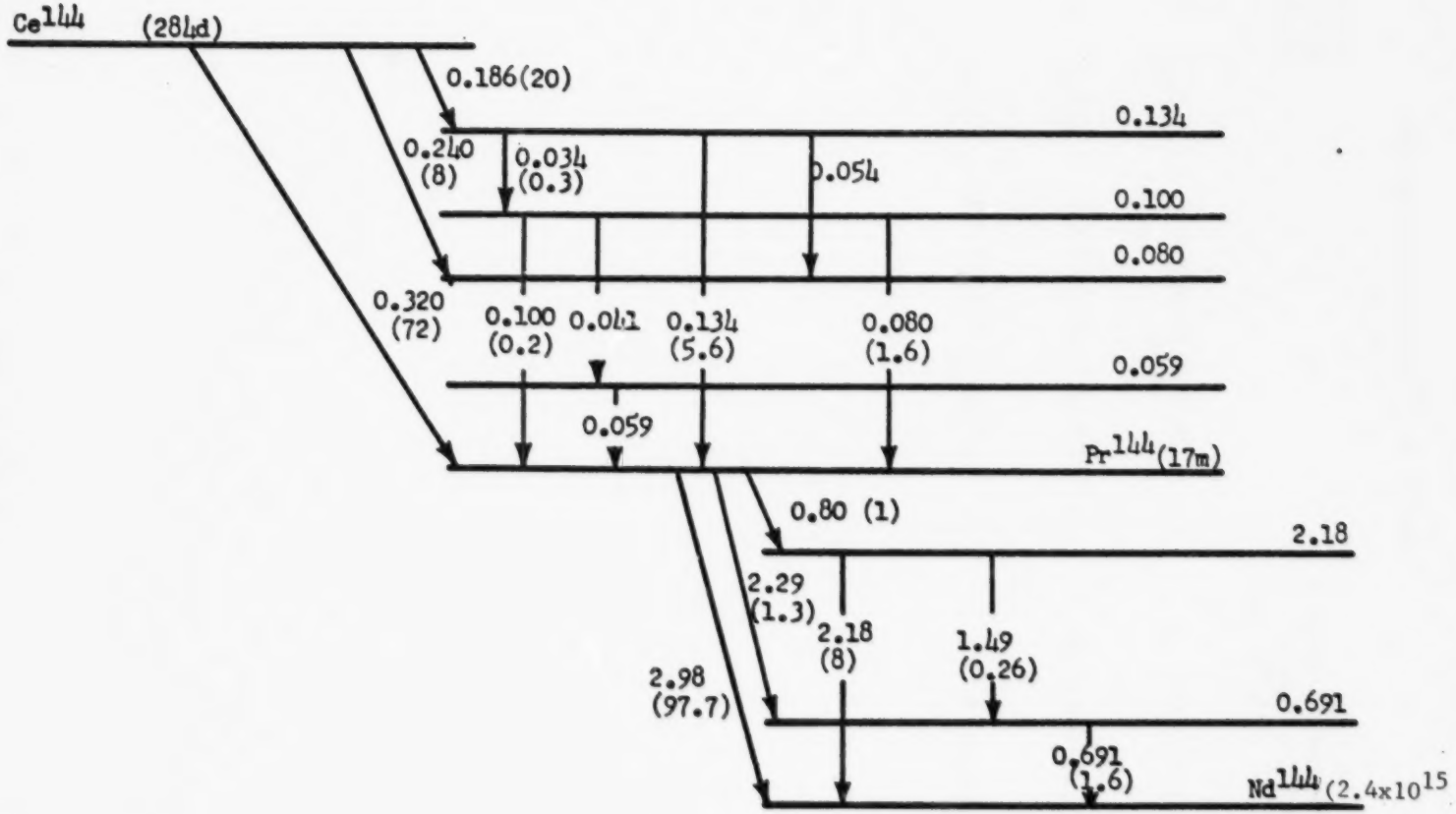
TIME: 1000 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 111,700 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate	Channel No.	Count Rate
06	33.59	53	0.58
07	73.18	54	0.57
08	46.80	55	0.56
09	48.67	56	0.68
10	22.29	57	0.45
11	18.59	58	0.60
12	15.25	59	0.47
13	13.58	60	0.50
14	11.01	61	0.45
15	9.09	62	0.44
16	7.76	63	0.45
17	6.58	64	0.46
18	6.07	65	0.31
19	5.78	66	0.36
20	5.37	67	0.36
21	4.76	68	0.38
22	4.55	69	0.39
23	4.10	70	0.52
24	3.76	71	0.54
25	3.25	72	0.64
26	2.96	73	0.79
27	2.61	74	0.89
28	2.35	75	0.73
29	1.90	76	0.72
30	2.04	77	0.54
31	2.34	78	0.51
32	3.38	79	0.43
33	6.08	80	0.40
34	8.59	81	0.38
35	8.75	82	0.41
36	6.52	83	0.47
37	3.85	84	0.46
38	1.98	85	0.43
39	1.05	86	0.37
40	1.02	87	0.38
41	0.75	88	0.36
42	0.78	89	0.42
43	0.77	90	0.36
44	0.66	91	0.33
45	0.75	92	0.32
46	0.63	93	0.33
47	0.64	94	0.33
48	0.67	95	0.31
49	0.62	96	0.27
50	0.52	97	0.27
51	0.57	98	0.23
52	0.67	99	0.19


SAMPLE: Ce 144 Pr 144 (equil)-STANDARD
ACTIVITY: 111700 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER 400 V
DATE: 11/20/63
COUNTING TIME: 1000 MIN
0.134
0.691
1.49
2.18
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0

Cerium-144 - Praseodymium-144 (equil) DECAY SCHEMES 12/12/63



Ce^{144} - Pr^{144} (equil) EFFICIENCIES
11-20-63

TIME: 1000 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 111,700 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 7}}{\text{dpm}} = \frac{73.18}{111,700} = 0.000655$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 6-9}}{\text{dpm}} = \frac{202.24}{111,700} = 0.00181$

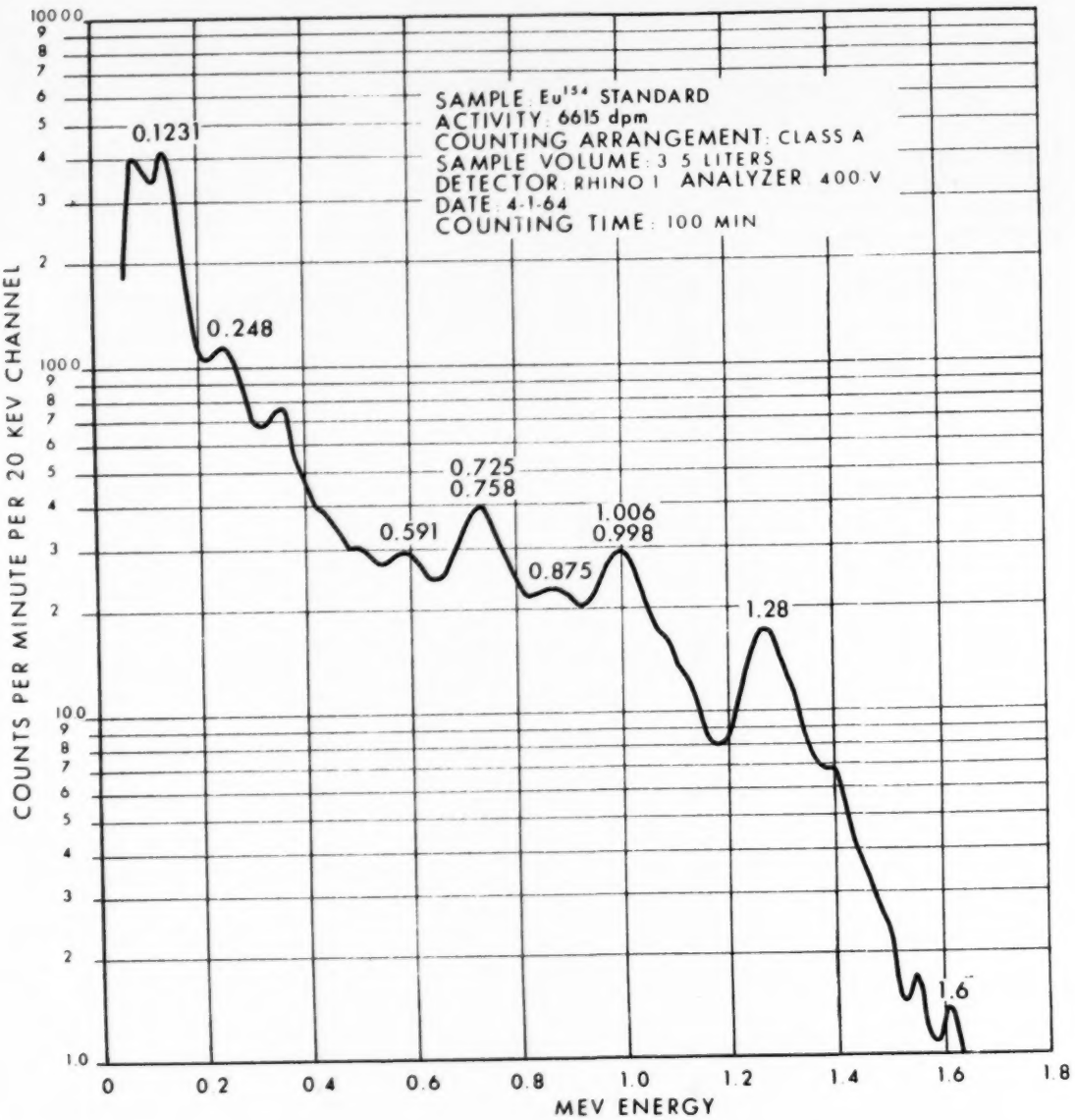
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 6-99}}{\text{dpm}} = \frac{429.15}{111.700} = 0.00384$

Eu^{154} STANDARD
4-1-64

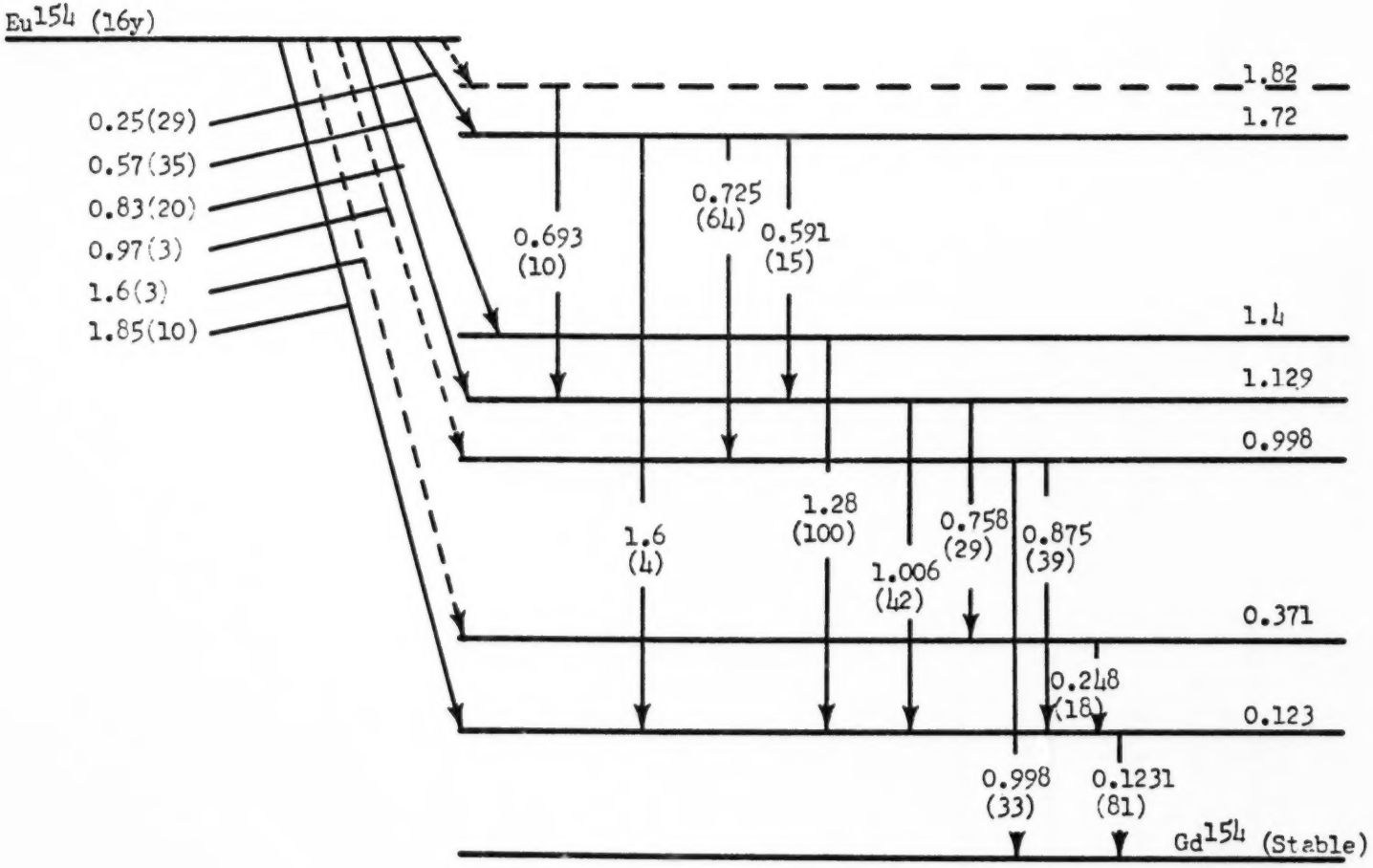
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 6615 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
03	181.43
04	398.50
05	360.19
06	339.44
07	419.03
08	325.02
09	152.48
10	113.84
11	107.03
12	113.01
13	113.41
14	95.25
15	71.22
16	68.86
17	75.63
18	76.30
19	58.76
20	46.95
21	38.40
22	37.40
23	34.95
24	30.42
25	30.68
26	28.20
27	27.25
28	28.30
29	29.66
30	29.00
31	27.37
32	24.68
33	25.00
34	29.32
35	34.21
36	38.70
37	38.67
38	33.20
39	27.52
40	23.93
41	21.99
42	22.14
43	22.95
44	22.52
45	21.48
46	20.11
47	21.82
48	25.55
49	28.93
50	29.04
51	25.36
52	21.20
53	17.55
54	16.17
55	13.72
56	12.83
57	10.39
58	8.09
59	8.04
60	9.70
61	12.57
62	15.19
63	17.65
64	16.08
65	13.52
66	10.69
67	8.33
68	7.02
69	6.65
70	6.38
71	4.94
72	4.72
73	3.27
74	2.76
75	2.15
76	1.48
77	1.78
78	1.29
79	1.12
80	1.40
81	1.16
82	0.92
83	0.38
84	0.46
85	0.36
86	0.26
87	0.17
88	0.22
89	0.33
90	0.15
91	0.10
92	0.07
93	0.00
94	0.00
95	0.00
96	0.00


SAMPLE: Eu154 STANDARD
ACTIVITY: 6615 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER 400 V
DATE: 4-1-64
COUNTING TIME: 100 MIN
0.1231
0.248
0.591
0.725
0.758
0.875
1.006
0.998
1.28
1.6
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8

Europium-154 DECAY SCHEME 4/30/64



Eu^{154} EFFICIENCIES
4-1-64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liter
ACTIVITY: 6615 dpm

20 Kev/channel
Net counts per minute
RHINO I

Total Peak Eff. $= \frac{\Sigma \text{ counts in Channel 63}}{\text{dpm}} = \frac{17.65}{6615} = 0.0267$

Total Photopeak Eff. $= \frac{\Sigma \text{ counts in Channels 60-66}}{\text{dpm}} = \frac{95.40}{6615} = 0.0144$

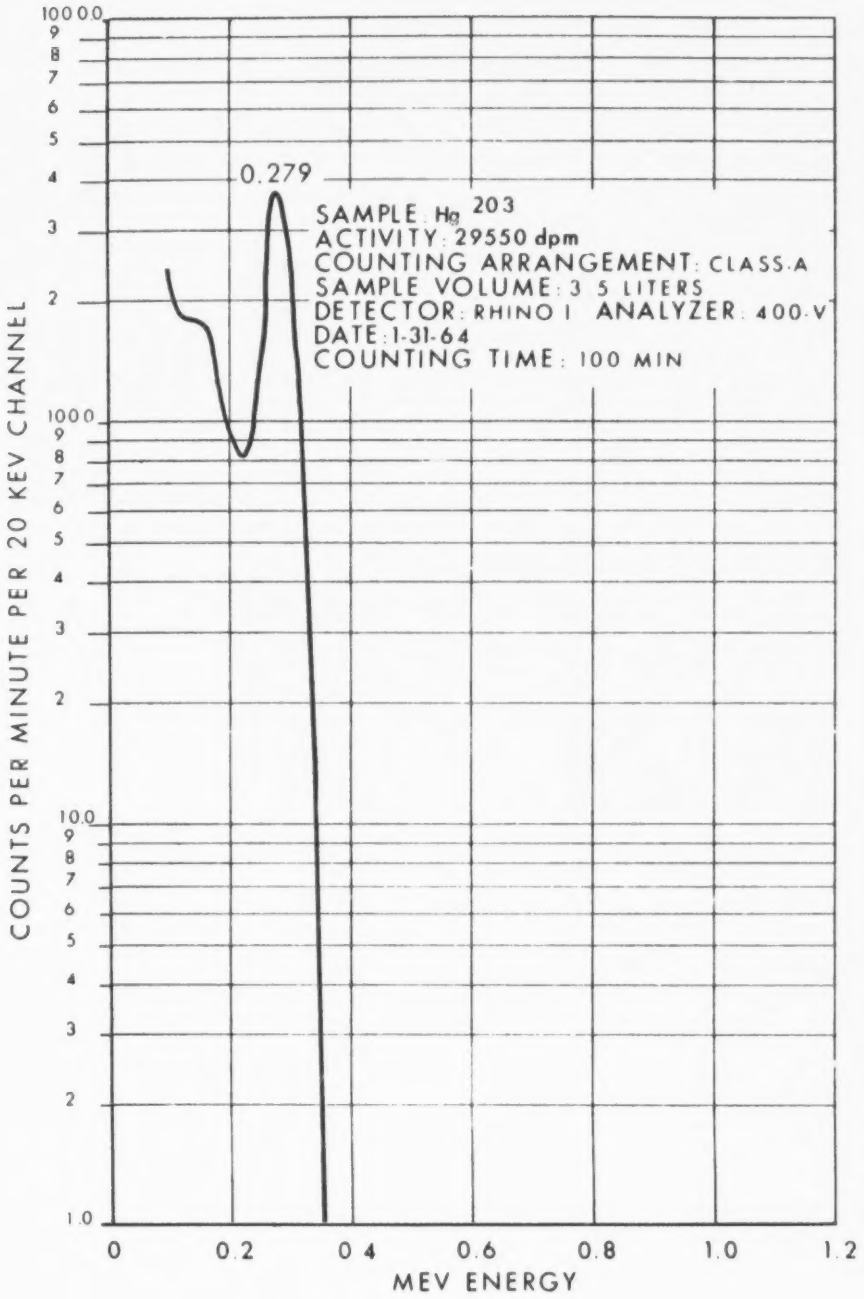
Total Gross Eff. $= \frac{\Sigma \text{ counts in Channels 3-99}}{\text{dpm}} = \frac{4256.35}{6615} = 0.643$

Hg^{203} STANDARD
1-31-64

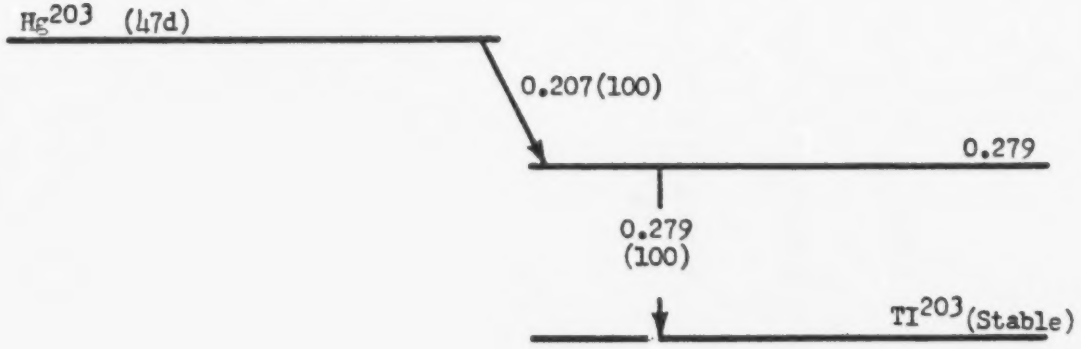
TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 29550 dpm

20 Kev/channel
Net counts per minute
RHINO I

Channel No.	Count Rate
05	237.23
06	183.65
07	176.81
08	176.17
09	134.99
10	96.84
11	81.91
12	95.83
13	215.61
14	365.84
15	257.32
16	85.76
17	13.23
18	0.67
19	0.45
20	0.36
21	0.39
22	0.15
23	0.0
24	0


0.279
SAMPLE: Hg 203
ACTIVITY: 29550 dpm
COUNTING ARRANGEMENT: CLASS A
SAMPLE VOLUME: 3 5 LITERS
DETECTOR: RHINO I ANALYZER: 400 V
DATE: 1-31-64
COUNTING TIME: 100 MIN
COUNTS PER MINUTE PER 20 KEV CHANNEL
MEV ENERGY
10000
1000
100
1.0
0
0.2
0.4
0.6
0.8
1.0
1.2

Mercury 203 DECAY SCHEME 12/12/63



Hg^{203} EFFICIENCIES
1-31-64

TIME: 100 min.
ARRANGEMENT: Class A
VOLUME: 3.5 liters
ACTIVITY: 29550 dpm

20 Kev/channel
Net counts per minute
RHINO I

$$\text{Total Peak Eff.} = \frac{\Sigma \text{ counts in Channel 14}}{\text{dpm}} = \frac{365.84}{29550} = 0.0124$$

$$\text{Total Photopeak Eff.} = \frac{\Sigma \text{ counts in Channels 12-16}}{\text{dpm}} = \frac{1020.46}{29550} = 0.0345$$

$$\text{Total Gross Eff.} = \frac{\Sigma \text{ counts in Channels 5-99}}{\text{dpm}} = \frac{2123.31}{29550} = 0.0719$$